Vol. 53 No. 4 April 1960

Quarterly

of the

National Fire Protection Association

INTERNATIONAL

Promoting the Science and Improving the Methods of Fire Prevention and Protection Since 1896

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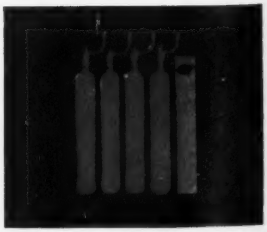

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Vol. 53 No. 4 April 1960

Quarterly

The Standard Technical Journal of Fire Protection for More Than Fifty Years

The NFPA is a non-profit technical and educational organization devoted to the reduction of loss of life and property by fire with a total membership of 17,000. The *Quarterly* is one of the publications regularly provided to members. Other membership publications include *Fire News*, *Advance Reports* to the Annual Meeting, a *Year Book*, and many leaflets, pamphlets and posters issued throughout the year on fire prevention and control. Six volumes of the National Fire Codes are available on an annual subscription basis, one volume free and others at reduced membership rates. For full details on available material ask for a free list of "Publications on Fire Prevention and Protection."

NFPA annual dues are $15.00 for Associate Membership of which $6.00 is for subscription to this Journal. National and regional societies or associations may apply for an organization membership for which annual dues are $100; such a membership entitles four individuals to receive the periodical membership publications.

Technical committees of the Association develop means to safeguard life and property through the publication of standards covering all phases of fire prevention and protection. Your membership in the Association affords an opportunity to keep abreast of these developments and, by being a member, you help support this humanitarian activity. Popular educational literature on fire safety is constantly being produced by the NFPA for distribution through its members to the general public.

National Fire Protection Association

International

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International

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Quarterly

of the

NATIONAL FIRE PROTECTION ASSOCIATION

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Articles and accounts of fires appearing in the Quarterly are based on material forwarded to the Association. The Association, as a body, does not assume responsibility for the accuracy of the material printed herein.

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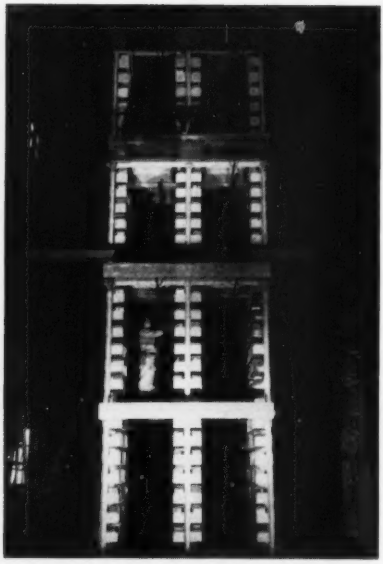

Figure 1. General view of 4-tier bookstack loaded with 11,200 books.

Bookstack

Size:	9 feet wide, 12 feet long, 30 feet high (four 7½-foot-high tiers)
Book Storage:	4 ranges of 4 compartments each in each tier
Shelves:	7 shelves in each compartment; all U-bar type except floor shelf which is solid
	Shelves are 3 feet long by 8 inches deep spaced 1 foot apart vertically except at floor and ceiling where spacing is 15 inches
	112 shelves per tier — 448 shelves total
Aisles:	3 feet wide — two 3-inch slots plus 30 inch walkway
Weight of Structure:	7,000 pounds

Books

Average:	25 per shelf, 175 per compartment, 700 per single range, 2,800 per tier, 11,200 total
Approximate Average Weight per Book:	1 pound dry, 2½ pounds soaking wet
Moisture Content of Books:	5 per cent to 9 per cent

Figure 2. Illustrates structural elements of stack; note one sprinkler position.

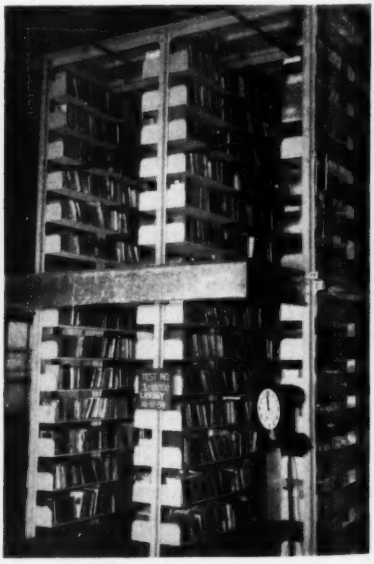

Figure 3. General view of books in first and second tiers before tests.

Fire Tests of Library Bookstacks

By P. E. Cotton, Assistant Director
Laboratories, Factory Mutual Engineering Division

Consideration of library fire protection usually brings out two questions. First, would fire be expected to spread in a bookstack? And second, if so, would automatic sprinklers keep the damage to a minimum? Two tests were made to find the answers to these questions. In both cases the tests showed the answers to be emphatically, yes!

The stack used in the tests is illustrated by Figures 1, 2, and 3. It is a segment of a typical library stack, consisting of a steel structure supporting steel shelves which hold discarded library books. This structure was purchased from and erected by a manufacturer of library equipment. In plan, the segment contains four ranges (lines of shelving) 12 feet long, facing on two aisles, 4½ feet on centers. Thus, the area occupied is 9 feet wide by 12 feet long. In elevation there are four tiers or stories, each 7½ feet high, making a total height of 30 feet.

Figure 4. Wood bookcart before being placed in aisle of first tier. After placement, books were put on top shelf of bookcart. The fire was started with an ordinary match by igniting the crumpled piece of paper between the two cartons on the bottom shelf of the cart.

Bookcart and Contents

Bookcart (shown in Figure 4) was made of wood (moisture content: 7 per cent) and was 15 inches wide, 42 inches long, and 36 inches high. During the tests 120 books were placed on the two top shelves (fully loaded) and the bottom shelf contained two open top cardboard cartons (12 x 12 x 8 inches). Each carton contained two crumpled wrapping papers which were 3 feet by 3 feet each and between cartons was crumpled wrapping paper 1½ feet by 3 feet. The weight of the cartons and paper was 2 pounds; the weight of the bookcart empty: 57 pounds. The test engineers considered this bookcart fire "a modest local ignition source" for these library tests.

Test 1 — With Automatic Sprinklers

For the first test, standard automatic sprinklers were installed in both aisles in all four tiers of the stack. Since the sprinklers were spaced the maximum practical distance apart in the aisles (15 feet), platforms were provided at each end of the stack to extend its effective length insofar as the sprinklers were concerned.

The fire was started in a small quantity of paper contained in a wooden bookcart arranged as shown in Figure 4.

Its location in one aisle of the lowest tier of the stack is illustrated in Figures 5 through 8, which also show the fire growth, the action of the sprinklers, and the limitation of damage.

In this test, one sprinkler opened in the second tier at 3 minutes, 43 seconds after the fire was lighted, and one sprinkler opened in the first tier 7 minutes, 53 seconds after the start. The sprinkler discharge stopped the spread of fire in the books almost immediately and gradually extinguished the fire. Note from the Temperature Graphs (Figures 18 to 21) that air temperatures under sprinkler protection did not exceed about 200°F and the temperature of the structural steel did not go above 500°F.

There was fire damage to books in 10 per cent of the storage space of the stack (see Figure 9) and this damage would be repairable for practically all of the books so involved. Books in an additional 27 per cent of the storage space of the test segment were wet in varying degrees ranging from dampness to soaking. All books so involved would be repairable by drying. Nine 3-foot-long shelf sections were deformed by heating although the structural members of the stack were unharmed except for paint damage.

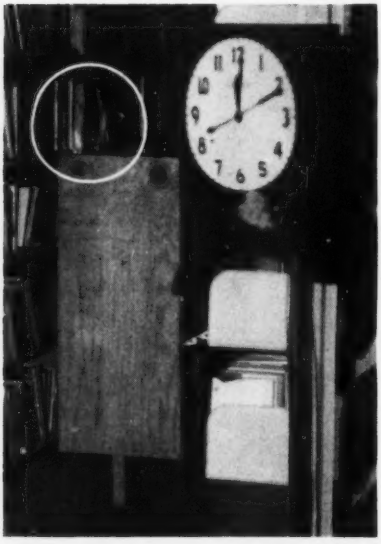

Figure 5. One minute, 10 seconds; flame showing above bookcart; sprinklers not yet operating.

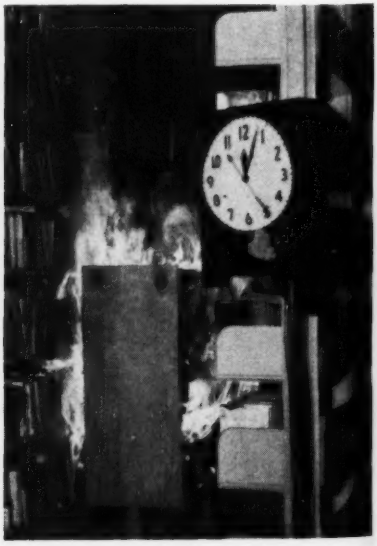

Figure 6. Three minutes, 25 seconds; active burning in first tier; sprinklers not yet operating.

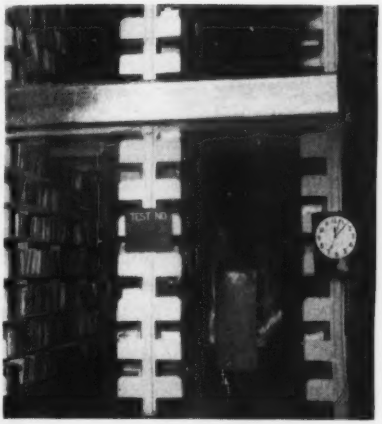

Figure 7. Eight minutes, 3 seconds; two sprinklers operating; fire in stack under control.

Figure 8. After fire extinguishment by sprinklers; fire damage to books in only 10 per cent of space.

Sprinkler Protection

The sprinklers used were 160° standard sprinklers, pendent mounted, on 4½ foot by 15 foot spacing staggered vertically and horizontally. There were sprinklers in all tiers and all aisles of the test library-bookstack set-up.

Sprinkler deflectors were located 10 inches below the ceiling and 6 inches off center to allow for fluorescent lighting in actual library installations.

The pressures were designed so that the static pressure at the end head on the top tier was 5 pounds per square inch; on the first tier, 14¾ psi; second tier, 11½ psi; and third tier, 8¼ psi.

The approximate discharge per sprinkler was 22 gallons per minute on the first tier, 19 gpm on the second tier, 16 gpm on the third tier, and 13 gpm on the fourth tier.

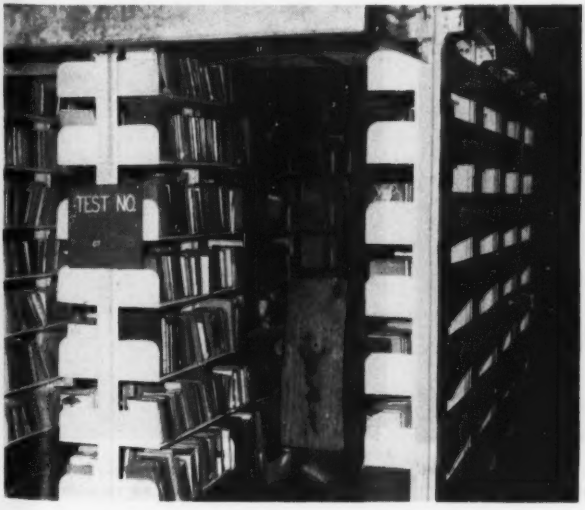

Figure 9. Close-up of extent of fire damage after Test 1 with automatic sprinklers. Note limited area of fire damage.

Test 2 — No Automatic Sprinklers

After replacing all fire and water damaged books and shelving following the first test, a second test was made using the same method of ignition.

The spread of fire upward through the four tiers of the bookstack is described best by the series of photographs, Figures 10 through 13. Added to this are the visual observations that books in the second tier began burning at approximately 3¼ minutes, in the third tier at 7½ minutes, and in the fourth tier at 9 minutes. By 10 minutes, there was intense fire in all areas of the bookstack except at the lower shelves of the first tier in the aisle not containing the ignition source. A 1-inch hose line supplying 15 gpm was used to attack the fire at 10 minutes, 23 seconds, followed by a 2½-inch hose line (265 gpm) 17 seconds later since the first stream was only slightly effective. These hose streams essentially extinguished the fire, although it smoldered for hours.

Some indication of the extent of damage to the books and stacks is given in Figures 14 through 17. Quantitatively, 89 per cent of the books were charred deeply or completely destroyed, 2½ per cent were scorched, and the remaining 8½ per cent were soaked.

Approximately three-fourths of the shelving was irrepairably damaged; some of the structural elements were visibly deformed (Figure 17); others would not be safely re-useable for live loads. These observations indicate that complete collapse of the structure was imminent when hose streams were applied. Figures 18–21 give a comparison of temperatures of various points in the structure for both tests. From these charts it will be noted, as indicated earlier, that the maximum temperature at any of the recording locations did not go above 500°F at any time during Test 1 when the automatic sprinklers were used. In contrast, temperatures of 1500°F were reached at each location, including those of the structural steel, during Test No. 2 where no sprinklers were available. Steel strength drops quickly at temperatures above 900°F.

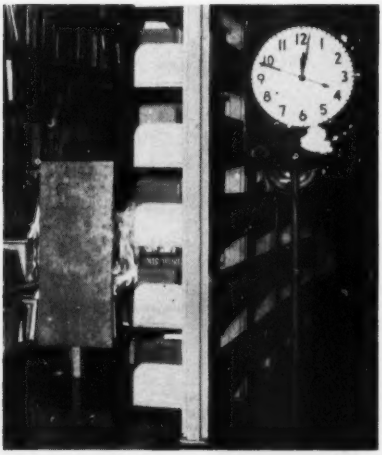

Figure 10. One minute, 48 seconds; books in stack ignited; no sprinklers.

Figure 11. After approximately 3 minutes; active burning in first tier; no sprinklers.

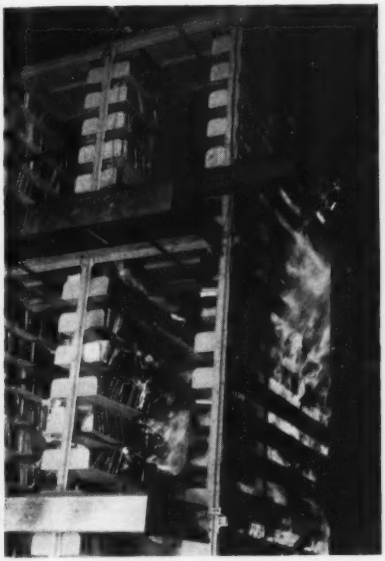

Figure 12. After approximately 7½ minutes, fire involved second and third tiers.

Figure 13. After about 9½ minutes, flame spread to top tier and across aisles on lower tiers.

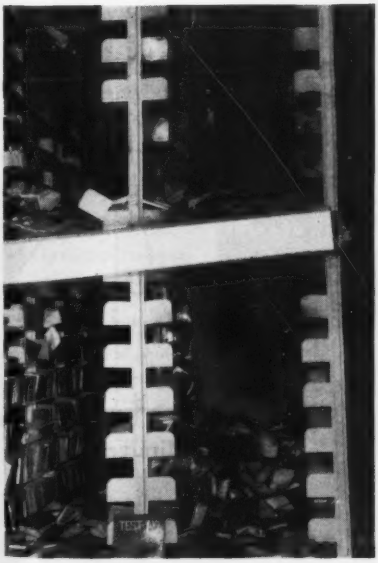

Figure 14. General view of first and second tiers after Test 2 (no sprinklers).

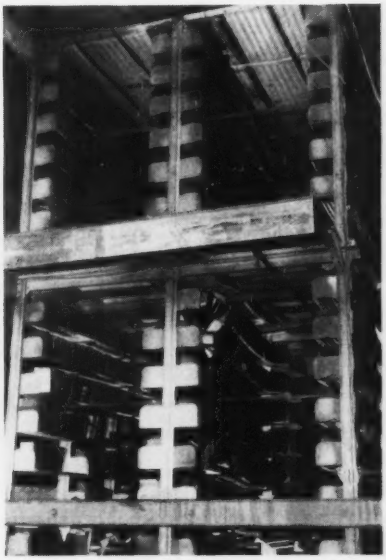

Figure 15. General view of third and fourth tiers; all exposed book surfaces charred.

Temperatures at Various Locations in Bookstacks

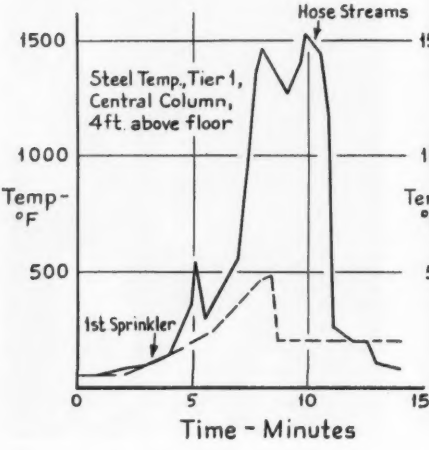

Figure 18.

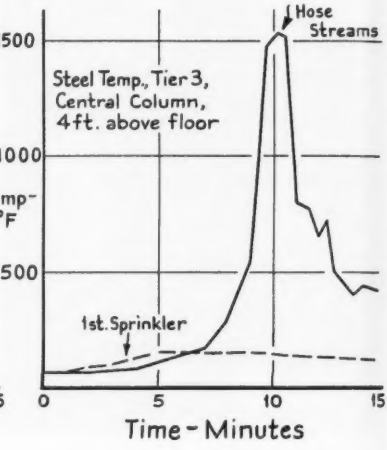

Figure 19.

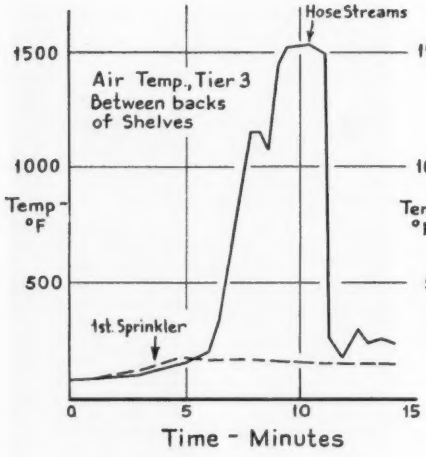

Figure 20.

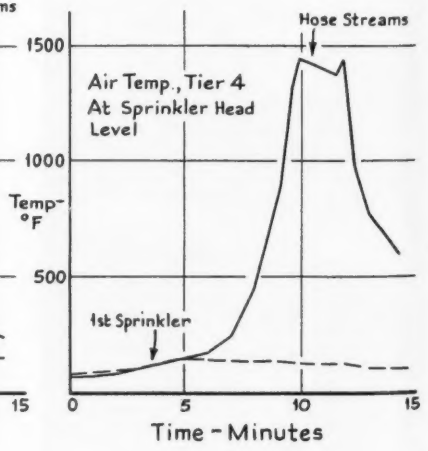

Figure 21.

– – – – Test 1 — With Sprinklers ———— Test 2 — Without Sprinklers

Figure 16. Extent of damage to shelving after Test 2 (no sprinklers) on second tier, right aisle. Note severe charring of books and collapse of shelving.

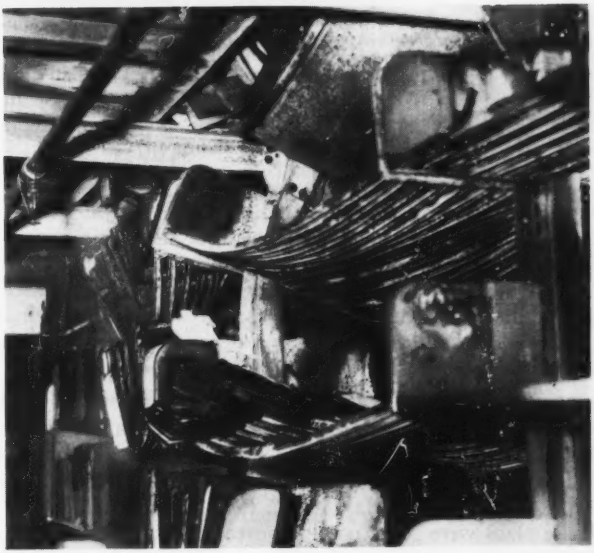

Figure 17. View of first tier, left aisle after Test 2 (no sprinklers). The temperatures reached 1500°F in each recorded location whereas in Test 1 (with sprinklers) temperatures did not go above 500°F. Note failure of column (center of photo).

Summary

From these results it is apparent that fire may be expected to spread quickly through library stacks from a modest local ignition source. It is also apparent that standard automatic sprinklers will fill their normal role of minimizing the consequent damage from a fire in library bookstacks.

Meeting of Board of Directors

Union League Club, New York, January 21, 1960

Members Present

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Henry G. Thomas, President
Loren S. Bush, Vice-President
J. Sharp Queener, Vice-President
John A. Neale, Past President
Hovey T. Freeman, Secretary-Treasurer

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Warren J. Baker
W. H. Berry
A. Sidney Briggs
Marshall B. Dalton
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W. H. Forristall
Clarence W. Higbee
Paul C. Lamb
Jerome Lederer
Elmer O. Mattocks
William L. Miller
John H. Redmond
Carroll E. Shaw
E. C. Wood

Merwin Brandon, Chairman, Electrical Section

Percy Bugbee, General Manager; Robert S. Moulton, Technical Secretary; Horatio Bond, Chief Engineer; Charles S. Morgan, Assistant General Manager; George H. Tryon, Assistant Technical Secretary.

Business Transacted

1. Mr. Bugbee reported on plans for the annual meeting and indicated an enthusiastic group of members in Montreal anxious to promote a successful meeting. Mr. Wood referred to Mr. A. Leslie Ham as Chairman of the local convention committee and indicated general cooperation in the promotion of the meeting.

Mr. Bugbee reported on plans for future meetings, including a meeting in Detroit, May 15–19, 1961; Philadelphia, May 14–18, 1962; San Francisco, May 20–24, 1963; Dallas, May 18–22, 1964. These plans were tentatively approved.

2. Treasurer Hovey T. Freeman presented the financial report, indicating that the Association's finances were in a healthy condition and predicting that the year's operations would be definitely in the black.

Staff Activities

3. Executive Office reports were presented as follows:

a. Mr. Bugbee reported on membership, indicating a break-through in the former plateau of 17,000 members with the expectation that the membership at the close of the present fiscal year would be approaching 18,000.

b. Mr. Bugbee reported on the Sponsors Committee, naming the various members and indicating the fine cooperation of the Chairman, Mr. Humphreys, of the United States Rubber Company. It was unanimously voted by the Board to express their thanks and appreciation to Mr. Humphreys for his excellent service as Chairman of the Sponsors Committee.

c. Mr. Morgan reported on advertising which is under the direction of Mr. Henry Gere, indicating a progressive growth in the advertising income. Advertising income for the present fiscal year for the QUARTERLY and for *Firemen* magazine is expected to be the greatest in the Association's history.

d. Mr. Bugbee reported on public relations commending the services of Mr. Deuel Richardson and indicating the widespread coverage the NFPA had received from various publicity releases recently issued.

e. Mr. Bond reported on the Fire Service Department, indicating the excellent service rendered by this department under the leadership of Mr. Warren Kimball.

f. Mr. Moulton reported on the Fire Record Department under the jurisdiction of Mr. Babcock with the assistance of Mr. Wilson, stating the important functions fulfilled by this department and the need for continuing and expanding service in this field.

g. Mr. Brandon reported for the Electrical Section and for the electrical field service project, reporting that Mr. Stetka, NFPA Electrical Field Engineer, is performing a most valuable function and maintaining closer correlation with NFPA general activities than had been the case with previous electrical field engineers. He indicated general satisfaction with Mr. Stetka's service.

Mr. Brandon also reported on a difficulty with respect to the 1959 National Electrical Code, indicating one detail in which through a misunderstanding the regular NFPA procedure had not been followed.

h. Mr. Elmer Mattocks, Chairman of the Committee on Flammable Liquids Field Service, reported on the extensive activities of Mr. Miles Woodworth, Flammable Liquids Field Engineer, the large number of projects under his supervision and general satisfaction with his services.

i. Mr. Baker reported on the Gases Field Service indicating similar satisfaction with the fine service rendered by Mr. Clark Jones, Gases Field Engineer.

j. Mr. Tryon reported on the *Handbook of Fire Protection*, indicating that approximately 30 per cent of the work had now been completed and the expectation of the NFPA staff that the job would be finished during the year 1960.

k. Mr. Morgan reported on the group insurance program indicating that this had been revised in accordance with suggestions from the advisory committee to give greater benefits to NFPA staff members. There was general discussion of this program with indication by Mr. Berry and others that it would be desirable to increase the amount of insurance provided at some future time.

Reports of NFPA Sections

4a. Mr. Morgan reported on the Fire Marshals' Association of North America indicating an increased vitality for this section and greater influence and prestige largely resulting from the change in the name to the Fire Marshals' Association of North America.

b. Mr. Baker, Vice-President of the Society of Fire Protection Engineers, reported for the Society, indicating a present membership of 1059, including new accessions received during the past week. He indicated a healthy condition for the Society and expressed the hope that its progress would continue along similar lines in the future.

Meeting at Des Moines

5. Mr. Bugbee reported on our Fall Conference in Des Moines last November. There was general discussion by President Thomas, Chairman Duke, Mr. Baker, Mr. Fee, and others, all indicating general satisfaction with the fall meeting programs and a need for continuing and expanding this phase of the NFPA service.

Mr. Bugbee referred to plans for holding the 1960 Fall Conference in Columbus, Ohio, reporting that Mr. Carl Setzer of the Ohio Inspection Bureau had agreed to accept the chairmanship of the Sponsoring Committee and indicating excellent prospects for a successful fall meeting.

6. Mr. Bugbee raised the question as to whether the NFPA office should consider plans to hold a Fall Conference in London, England, in the fall of 1961 indicating the various advantages that might accrue from such a meeting. Following discussion by Messrs. Led-

erer, Auck, Baker, Queener, Bush, and Redmond, it was voted to authorize the NFPA staff to proceed with the investigation of plans for such a meeting and to arrange it if in their judgment the plans proved feasible. During the discussion various aspects of the situation were brought out, including the relatively small cost of airplane transportation from East Coast points to London and the advantages to industry through a wider participation in European affairs. Mr. Fee also emphasized the need for continuing the program of fall meetings in the United States, expressing the hope that the London meeting would not preclude further emphasis on meetings in the States.

7. It was unanimously voted to instruct the NFPA staff to continue the established procedure for copyrighting all NFPA standards and to take such measures as they deemed necessary to maintain the legal status of the copyright provisions.

8. In response to a question from the staff concerning distribution of NFPA publications through memberships addressed to countries behind the Iron Curtain, it was voted to authorize the staff to accept such memberships at their discretion.

Technical Advisory Committee Report

9. The report of the Technical Advisory Committee was accepted, including action on the following topics:

It was voted to restrict the representation of the National Electrical Manufacturers Association on the Committee on Signaling Systems and Thermostats to one member with one alternate. Mr. Moulton reported at this point that the National Electrical Manufacturers Association had accepted this suggestion and named their representative accordingly.

It was voted that the Flammable Liquids Committee and other committees charged with special hazards be assigned primary responsibility for determination of the character and extent of hazardous areas and that the National Electrical Code Committee be charged with the responsibility for determination of electric wiring and equipment suitable therefor.

It was voted to change the name of the Committee on Hospital Operating Rooms to Committee on Hospitals and enlarge its scope to permit it to cover emergency electrical systems for hospitals.

It was voted to establish a new Committee on Electronic Computer Systems with scope to cover electronic machines and surroundings and the storage of records in connection therewith.

It was voted to change the name of the Committee on Trailers and Trailer Camps to "Trailers and Trailer Courts."

It was voted to reorganize the Committee on Salvaging Operations so that it would report to the Association through the Committee on Fire Department Equipment.

10. On recommendation of the Technical Advisory Committee, the list of committee appointments presented to the Board with the agenda was confirmed, also a supplementary list of committee appointments. (These appointments have been recorded in the February 1960 *Fire News* and are accordingly not included here.)

It was also voted to appoint Mr. Paul Lamb as a member of the Technical Advisory Committee to succeed Mr. Hylton Brown, retired.

11. Mr. Moulton reported on technical committee activities, referring to 62 committee meetings held in New York during the current two-week period, mentioning the continuing devoted service of committee chairmen, the organization of a new Committee on Electronic Computer Systems, and the extensive activities of the NFPA Committee on Safety to Life. He referred to the Conference on Life Safety in Schools to be held on January 22 and extended an invitation to all Board members to be present. He also referred to the plans of the Committees on Chemicals and Explosives and Dust Explosion Hazards to subdivide their work into a group of sectional committees following the established pattern of the Committees on Gases and Flammable Liquids. He indicated that this plan would be followed and the revised committee organization setup submitted to the Board for confirmation at a later date.

Other Reports

12. Chairman Bond reported for the Committee on Research, explaining the organization of this new committee and its possible constructive service in publicizing research projects.

13. Mr. Tryon reported on publications, indicating that 50,000 individual requests had been received for publications during the current year with a substantial increase in the number of publications of all types and a total distribution of some nine million items.

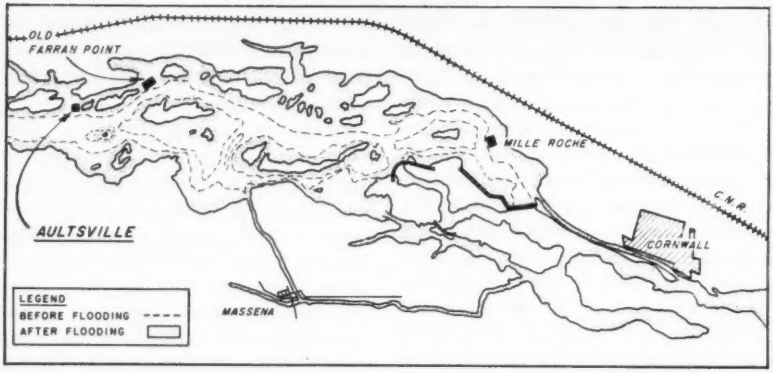
14. President Thomas reported on a recent meeting in Washington of the National Fire Defense Advisory Committee of the Office of Civil Defense and Mobilization at which he had represented the NFPA, describing the various actions taken including projects to promote mutual aid and fire department officer training.

15. Mr. Tryon reported on the activities of the Aviation Committee in following up the resolution adopted by the Association at its last meeting in furtherance of fire research in the field of aviation. Mr. Tryon reported on the efforts of Messrs. Lederer, Hansberry, and himself, in Washington and indicated some hope that as a result thereof some further attention might be given to aviation fire research.

Other Business

16. Mr. Bugbee presented a communication from the Dominion Fire Commissioner suggesting that the NFPA might perform a more useful function in furtherance of fire safety in Canada through the establishment of some more effective channels for international cooperation. On motion of Mr. Wood, it was voted to advise the Canadian Fire Commissioner that his communication would be carefully considered and that he would receive a report thereon at a later date.

17. Mr. Hovey Freeman reported on a recent fire in which an entire family had been wiped out, indicating the serious problems involved and the unfortunate effects of commercial promotions of substandard home fire equipment. There was general discussion of this matter, including mention of home fire alarm systems, the importance of fire department inspection, general need for public education, and other phases of this important field. The matter was referred to the NFPA General Manager for further consideration.



The St. Lawrence Burns

By G. W. Shorter, J. H. McGuire, N. B. Hutcheon, and R. F. Legget
National Research Council, Canada, Division of Building Research

When it became known that the St. Lawrence Power Project would result in the flooding of a large area on the Canadian side of the St. Lawrence River, which included a number of small towns, the Division of Building Research of the National Research Council (Canada) realized that this would provide an excellent opportunity to carry out fire research experiments on derelict buildings. Through the cooperation of the Hydro-Electric Power Commission of Ontario, the Federal Civil Defence authorities arranged that a number of buildings in the Village of Aultsville would be made available for experiments and the Division of Building Research was given the opportunity of selecting suitable buildings for carrying out controlled experiments.

An invitation to assist in the experiments was accepted by the British Joint Fire Research Organization. Assistance was given in planning the operation and in the provision of certain instruments and a senior scientific officer was sent to participate in the tests.

The studies, conducted in January and February of 1958, concerned only the development of fire in buildings; they did not include any investigation of the extinguishment of fire. The studies were limited to the development of fire as it affects (a) survival of the occupants, (b) spread of fire by radiation, and (c) ventilation rates. It was thought that instrumentation installed to study these phenomena might also provide further evidence as to the validity of the "time-temperature" curves that are used in standard fire resistance tests.

As the number of buildings that could be instrumented and burned had to be limited, it was decided that major variables in the experiments with dwellings would be limited to the types of interior linings and exterior claddings. These were classified broadly as combustible and noncombustible. A search was made for a series of dwellings which in all other respects were similar. With this restriction, six two-story dwellings were selected for the experiments. Three had noncombustible linings and, after minor modifications, three were considered to have combustible linings, at least on the ground floor. One dwell-

NOTE: The first portion of this article is based on a paper presented by Mr. Legget at the May 1958 NFPA Annual Meeting.

ing in each of these categories had timber exterior cladding; all dwellings had wood floors and subfloors.

The interest in burning larger buildings came, in the first instance, from the British Joint Fire Research Organization. Information was desired on the influence of large compartment size on the nature of the fire, and on the ventilation rate provided by the induced air flow through openings during a fire. The choice of larger buildings was limited to two, a two-story school and a two-story community hall, both of brick construction.

Wall construction details for all eight buildings are given in Table I. Studies concerned with the survival of the occupants in buildings were restricted to the dwellings. Those related to the spread of fire by radiation were carried out at all eight buildings; those dealing with ventilation rates were restricted to the two large structures, apart from a preliminary trial at the first house burn.

Table I
Construction Details of Walls

Building No.	Exterior Wall	Interior Linings
1*	brick	plaster
2*	brick and 1 inch rough boards	fiberboard downstairs (except kitchen wainscot which was wood)
3*	cavity brick	fiberboard
4*	frame, brick infilling, 1 inch boards, clapboard	plaster
5*	frame, 1 inch boards, cedar shingles, clapboard	pressed paper
6 (Community Hall)	brick	plaster, wood wainscot
7*	brick	plaster
8 (School)	brick	plaster

*Dwellings

Specific Objectives

The specific experimental objectives for determining the effects of the development of fire on the survival of the occupants, the spread of fire by radiation, and ventilation rates were as follows:

Survival of the Occupants

The main objective was to determine the times at which survival of occupants became impossible in two upstairs bedrooms (one with the door closed and one with the door open) and in the basements of the dwellings.

Instrumentation was provided for determining the concentrations of carbon monoxide and oxygen, smoke density, and the rise in temperature in each area. In addition, microphones were installed to determine if the noise that a fire makes prior to the time at which survival is impossible offers any warning to the occupants of upstairs bedrooms.

Spread of Fire by Radiation

When determining separations between buildings to reduce the hazard of the spread of fire from one building to another, a major factor to be considered is the spread of fire due to radiation. An objective, therefore, was to determine at what distances intensities of radiation would be sufficient to ignite combustible materials in adjacent structures. Small portable radiometers mounted on movable standards were used for measuring radiation intensities. When estimating space separations between buildings, it is necessary to assume a limiting intensity of radiation from a burning building.

Another objective was to measure the intensity of radiation at the window openings. A thermopile radiometer was mounted on a tripod in front of a window of the room where the fire was set. The window completely filled the field of view of the radiometer.

Malak, Ottawa

One of the dwelling house "burns" being filmed by the National Film Board.

To determine to what distance the flames extended from the building on the leeward side, standard motion pictures were taken during periods of peak radiation from a point in line with the leeward wall.

Ventilation Rates

A factor in the development of fire, which is of great interest to those engaged in fire research, is the effect of ventilation, particularly in large single compartments. As there is little information on this subject, a study was made of the rate of ingress of air during the development of the fires in the two large buildings. For these measurements two small specially fabricated anemometers were installed in window openings.

Outline of Operations

The detailed survey of the buildings included taking photographs and measuring all rooms so that floor plans could be drawn. Small plot plans were prepared showing the location of the several buildings. Arrangements were made for heating the buildings for approximately one week prior to the actual fire, with portable space heaters loaned by the Ontario Hydro.

Few modifications to the buildings were necessary. These consisted merely

of adding small amounts of lining materials in ground-floor rooms and in the stairways leading to the upper floors, where necessary, in order to have combustible finishes in three of the houses and noncombustible finishes in the other three. The second floors of the two larger structures were removed to convert them into large single compartments.

All recording and indicating instruments were installed in a trailer which was located approximately 100 feet from any structure. This trailer was heated and provided shelter from the cold weather for both instruments and staff and also facilitated the movement of the instruments from one location to another. The main equipment installed in the trailer was the apparatus for gas analysis and a number of recording instruments.

Arrangements were made with the Ontario Hydro to supply power on poles near the various buildings to be burned. In two cases a 20-kva portable generator was provided where no power lines were conveniently available.

Fire protection provided by staff from the Ontario Fire Marshal's Office and by the Ontario Hydro ensured that the fires did not spread to adjacent properties. Except on one or two occasions, it was not necessary to use the fire-fighting equipment and personnel provided so far as the safety of life or property was concerned, but they performed a useful function in keeping the fires from spreading from the buildings proper to attached sheds, the burning of which would have influenced the results of the tests.

It was known that one of the most important results of such an operation should be a pictorial record, and the services of the National Film Board of Canada were obtained to take motion pictures during the operation. These movies consist of approximately ½ hour of film for each fire, taken from a fixed position and a number of random shots used for the preparation of a 20-minute documentary film of the operation.*

Equipment was also provided for obtaining necessary weather records during the fires. The most important item was wind speed and direction, because of its effect in projecting the flame front some distance from the window openings of the burning building.

Prior to the tests, all lines leading from instrument installations in the buildings were connected by leads to the trailer. Moisture content of the wood in the cribs and ground-floor interior finish materials was measured. The space heater was then removed from the building, a door or window left open to provide ventilation, and a final inspection of the premises carried out immediately before the cribs were ignited. Even though measurements were being recorded, one member of the team was assigned to make visual observations during the fires. Once the cribs were ignited, the staff of the NFB began filming, using both a static and a mobile camera.

Five of the residences were burned in the middle of January 1958 and the sixth residence and the two larger structures early in February. In spite of considerable variation in weather during this period both as to wind and temperature, the instrumentation functioned satisfactorily. A good deal of equipment was specially designed so that it could be recovered before damage occurred. In general, this phase of the operation was successfully carried out except in the case of the largest structure where

*Available on loan from N.R.C. Liaison Officer, B.C.S.O., K Street N.W., Washington (for U.S.A.); or from Director, Division of Building Research, National Research Council, Ottawa.

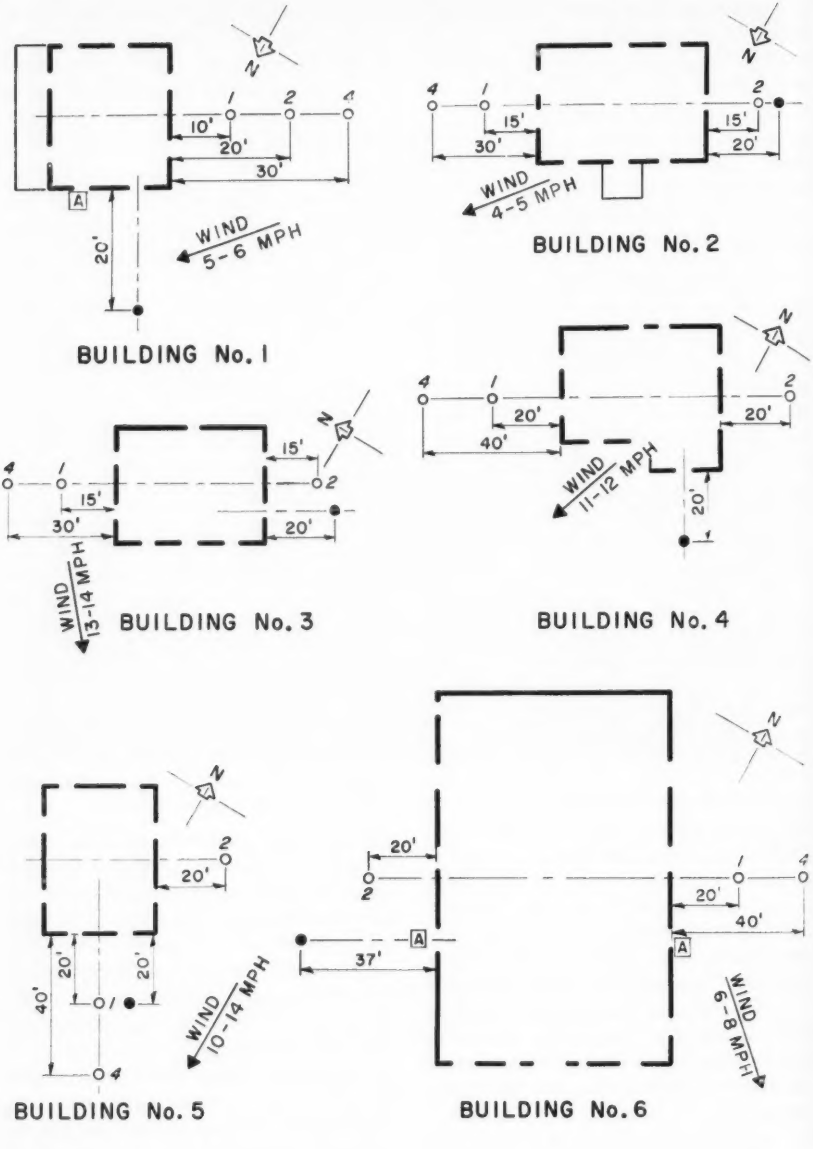


Figure 1.

Location of radiometers.

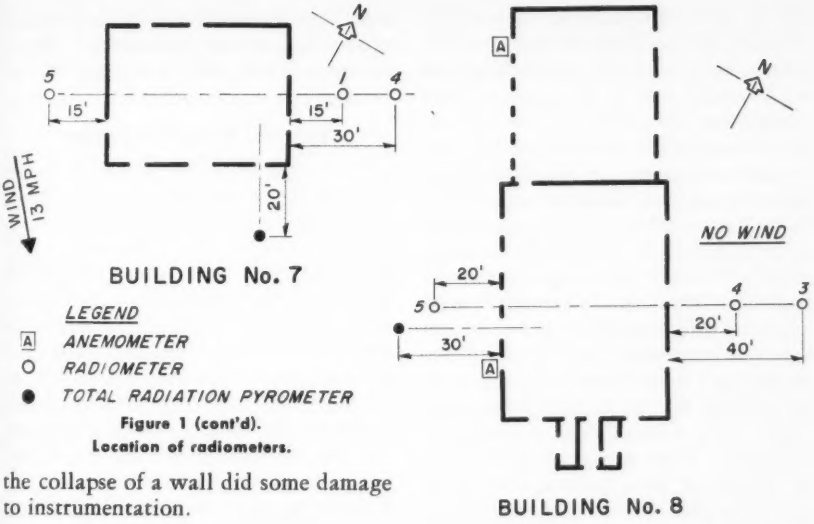


Figure 1 (cont'd).
Location of radiometers.

the collapse of a wall did some damage to instrumentation.

Ignition and Fuel

It was decided that a fire capable of rapid growth should be set at each burn. Accordingly, since the buildings were without furniture, two identical cribs of new wood in sizes from ½ by ½ inch, to 2 by 4 inches and each weighing about 340 pounds were constructed in the room of origin in each house. This weight of wood corresponded to a fire load in the room of origin of about 3 pounds per square foot, which is typical of the fire load due to furnishings in ground-floor rooms.

The fire was always started in the crib, all time measurements being made from the minute the crib was well alight. The fuel load in the two larger structures was formed by the wood flooring which had been removed from the upper floors and piled on the ground floor. The fires were started in these piles of fuel.

Instrumentation

Instrumentation was required to provide information on (a) the limiting times at which life could be sustained in the bedrooms of the dwellings and (b) the levels of radiation outside the dwellings that might give rise to fire in neighboring buildings.

It was assumed that death generally results from a high concentration of carbon monoxide, a low concentration of oxygen, or a high temperature. High smoke density would result in poor visibility, making escape difficult. Measurements of all these quantities were made. Carbon monoxide and oxygen were measured at 30-second intervals with continuous sampling equipment; the sampling locations were two bedrooms, one with the door open and the other with the door closed. Measurements of smoke density were made by an optical attenuation method in the two bedrooms. Temperature was measured by chromel-alumel thermocouples of which between ten and sixteen were distributed throughout each dwelling. Tape recordings were made of the sounds created by the fire in the two bedrooms.

The intensities of radiation near the burning buildings were measured by

totally enclosed, gold disc radiometers specially designed for this series of experiments. In general two radiometers were located at different distances from the leeward side of a building and one on the windward side (Figure 1). The nearer radiometers, in the case of the house burns, were mounted at a height of 15 feet at which, it was estimated, the radiation level would be a maximum. During the burning of the larger buildings the nearer radiometers were mounted at a height of 20 feet which was the maximum possible with the mounting systems used. It was estimated that the intensity of radiation might have been slightly greater at a level some 5 feet higher than this. In all burns the most distant radiometer was mounted at the more convenient height of only 10 feet because, with the ranges involved, no great variation of intensity with height, up to about 30 feet, was expected.

The total radiation at a window in the room of origin of the fire was measured with a thermopile radiometer to provide a basis for comparison of the radiation from the window openings alone with that from windows plus the flames issuing from them as measured by the gold disc radiometers. Since the thermopile radiometer was arranged so that the window occupied completely its field of view, it could also be regarded as a pyrometer for purposes of calculating the black body temperature of the fire within, as seen through the window. This instrument will subsequently be referred to as the pyrometer to distinguish it from the others.

No smoke, gas, or sound measurements were made in the two large buildings. Radiation and temperature were measured as for the dwellings. A deflection-type anemometer was designed so as to be rugged and to function over a wide range of temperature in order to obtain the air speeds through open windows during the fire. Measurements were made by reading the instrument through a telescope.

Survival of the Occupants

For oxygen concentration, a lower limit of 10 per cent was assumed, based on the report of the National Fire Protection Association Committee on Fire Gas Research.[1] The limit for carbon monoxide concentration has been found to be a function both of concentration itself and of total dosage. Hamilton and Johnstone[2] have reported that, at a concentration of 1.28 per cent carbon monoxide by volume, there is an immediate effect and consciousness is lost. For lower concentrations it is generally agreed that consciousness is lost when 40 to 50 per cent of the blood haemoglobin is converted to carboxy-haemoglobin. This effect will be more nearly a function of total dosage rather than concentration. Minchin[3] reports that collapse will occur when the product of the carbon monoxide concentration, K_{CO} (per cent), and time of exposure, t (minutes), equals 4.5. This law has been assumed valid where K_{CO} has been a function of time and has thus been taken as:

$$\int_0^t K_{CO}\,dt = 4.5$$

The limiting value of temperature adopted was 300°F following the example set by other workers.[4]

All temperatures used in considerations of survival times were taken from thermocouples located 4 feet above the floor. This level was at the approximate midheight of the room and, in addition was considered a satisfactory compromise between breathing levels for standing, sitting and sleeping positions.

The criterion for impaired visibility is that used by Kingman and others.[5]

This depends on the assumption that when visibility falls to 4 feet, a room is smoke-logged to a degree that would seriously impede the escape of the occupants. From the data given by Kingman and others[5] it can be inferred that the 4-foot visibility limit can be considered to have been reached when the light transmitted through the 2-foot smoke path of the instrument used was reduced to 5 per cent of the intensity obtained in the absence of smoke.

The resulting times of survival, based on these several criteria, are given in Table II. Except in one instance the times based on the 4-foot visibility criterion are substantially less than the others. The carbon monoxide, oxygen, and temperature criteria relate to loss of consciousness (or in the last instance, death) whereas the smoke criterion relates to a substantial limitation in the visual powers of the occupant. Accordingly, the important results, considering the mean curves only, are those given in Table III. The difference in time resulting from the use of noncombustible instead of combustible linings, when the door is closed, is clearly critical since a period of 10 minutes is typical of the time it might take a fire appliance to respond to an alarm and effect a rescue.

Table II
Limiting Times of Survival (Minutes)

Type of Wall Lining	Building No.	Closed Bedroom $K_{CO} \times t = 4.5$	1.28% CO	10% O_2	300°F	4-ft. visibility
Noncombustible	1	12.0	13	13	11.8	3.9
	4	14.8	14.8	21.0	16.5	5.2
	7	16.2	18.6	19.2	11.3	5.7
Noncombustible (mean curve)	1, 4 & 7*	14.5	18.6 (b)	20.2 (a)	11.7	4.4
Combustible	2	10.0	5	5	7.8	—
	3	7.5	5.6	12.9	—	4.4
	5	7.0	4.8	8	9.1	3.4
Combustible (mean curve)	2, 3 & 5*	7.5	5.6 (b)	12.9 (b)	8.7 (b)	3.4 (a)

Type of Wall Lining	Building No.	Open Bedroom $K_{CO} \times t = 4.5$	1.28% CO	10% O_2	300°F	4-ft. visibility
Noncombustible	1	4.5	1.8	2.5	2.8	—
	4	7.0	12.1	3.6	11.5	2.4
	7	10.0	8	7.7	2.1	2.0
Noncombustible (mean curve)	1, 4 & 7*	8.0	12.1 (b)	4.2	2.5	2.1
Combustible	2	4.2	1.5	2.4	1.5	1.9
	3	5.0	2.5	2.3	1.7	1.5
	5	5.5	2.9	2.7	2.2	2.2
Combustible (mean curve)	2, 3 & 5*	5.0	2.9 (b)	2.5	1.8	1.6

*these values are taken from the curves of the means of the quantities
(a) indicates that only two results were available at the time considered
(b) indicates that only one result was available at the time considered

Table III
Critical Times for Survival
(neglecting visibility criteria)

Type of Wall Lining	Closed Bedroom	Open Bedroom
Noncombustible	11.7 min. (300°F)	2.5 min. (300°F)
Combustible	5.6 min. (1.28% CO)	1.8 min. (300°F)

Radiation Levels

During the first burn the three radiometers were located at different distances from the same side of the dwelling, in order to record the relation between radiation level and distance from the house. The direction of the wind greatly affected radiation levels, those on the leeward side being the greater because of the larger volume of flame issuing from the windows on this side. It was therefore decided that measurements should be taken on both sides of the buildings; for subsequent burns one radiometer was therefore located on the windward side and two on the leeward side. The peak radiation levels recorded are listed in Table IV.

The measured radiation levels for the various burns are difficult to compare directly, since they apply to the particular window and flame patterns viewed by the instruments for each building. They have been converted to another

Table IV
Maximum Radiation Intensities

Burn and Bldg. No.	Exterior Cladding	Interior Lining	Radiometer Nos.	Max Intensity I (cal/cm²/sec)	Config. factor of openings	I/F (cal/cm²/sec)
1	Brick	Plaster	1	0.12*	‡	‡
			2	0.15	‡	‡
			4	0.09	‡	‡
2	Brick	Downstairs — fiberboard and plywood	1	0.47	0.05	9
			4	0.18	0.016	11
		Upstairs — plaster	2	0.08	0.04	2
3	Brick	Fiberboard	1	1.25	0.034	37
			4	>0.18	0.013	>14
			2	0.46	0.034	14
4	Clapboard	Plaster	1	0.56	0.032	18
			4	0.17	0.011	15
			2	0.46	0.028	16
5	Clapboard	Pressed paper	1	1.05	0.027	39
			4	0.32	0.008	40
			2	0.35	0.012	29
6 (Community Hall)	Brick	Plaster; wooden ceiling	1	0.9	0.075	12
			4	>0.41	0.031	>13
			2	0.42	0.075	6
7	Brick	Plaster	1	0.9	0.058	16
			4	0.38	0.018	21
			5	0.08	0.044	2
8 (School)	Brick	Plaster; wooden ceiling	4	0.83	0.049	17
			3	0.17	0.019	9
			5	>0.5	0.088	> 6

*Radiometer removed before peak level attained
‡Not calculated

Ontario Hydro

First house to be burned about 13 minutes after ignition. Note radiometers in position.

basis for comparison, however, which is considered to be revealing and useful, on the assumption that the radiation level produced by a window plus its flame pattern can be represented by a hypothetical radiation intensity effective from the window area alone. The measured radiation intensities have therefore been divided by the configuration factor F as normally used in radiant energy transfer equations, calculated for the window openings alone with respect to the radiometer location. This approach not only permits a direct comparison between burns to be made but it may also be extended to the prediction of radiation levels at points other than those at which measurements were made, by multiplying the hypothetical window radiation intensities by other appropriate configuration factors relating the window areas to the points in question.

Some justification for this basis of comparison is provided by the reasonable agreement for the house burns between the results expressed in these terms from the two radiometers on the same side of the building. In the case of the school burn, however, the agreement is poor, because the windows of the school annex contributed substantially to the configuration factor F for the more distant radiometer but not for the nearer one. When the radiation from the main body of the building was a maximum, the fire in the annex was not yet fully developed.

Values of I/F were not derived from the results of the first burn because the more distant radiometers were also irradiated by a shed which ignited earlier than was expected. In later experiments ignition of sheds was suppressed and the buildings were stripped of porches and verandas that would have substantially influenced radiation measurements, thus eliminating a highly variable, complicating factor.

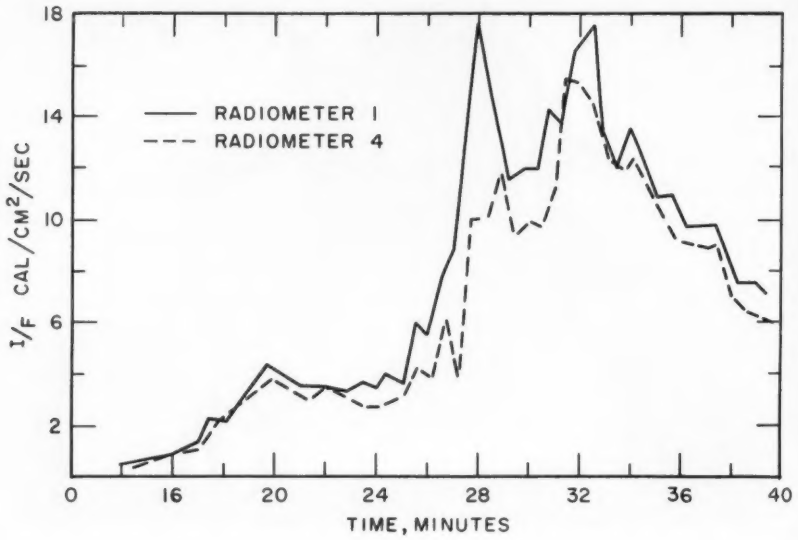


Figure 2.

Normalized radiometer results: Burn No. 4.

The best agreement was for building No. 4 as is illustrated in Figure 2. The levels of radiation differed by a factor of the order of three but the two curves of I/F almost coincide. The maximum values of I/F for the 4th and 7th burns correspond quite closely, as do those for the 3rd and 5th burns (Table IV). It would therefore appear that the use of clapboard exterior cladding does not appreciably increase the maximum radiation levels from a house. Where the dwellings had combustible interior linings, as in burns Nos. 3 and 5, values of I/F of up to 40 calories per square centimeter per second (cal/cm²/sec) were obtained. Where the linings were noncombustible, as in burns Nos. 4 and 7 and the two larger buildings, the maximum values were no more than half this. Building No. 2 gave a maximum value of only 11 cal/cm²/sec although it included fiberboard and plywood linings downstairs. It is thought that this was due partly to the absence of combustible linings upstairs and partly to the low speed of the prevailing wind.

Comparison may usefully be made between the values of I/F just cited and the pyrometer measurements of internal temperatures discussed later. At no time was a black-body temperature higher than 1000°C (1832°F) recorded, although it is possible that a slightly higher temperature might have developed in the Community Hall about 32 minutes after the start of the fire. The radiation level correspond ng to a black-body temperature of 1000°C is 3.6 cal/cm²/sec. It therefore follows that the window openings themselves only made a small contribution to the peak levels of radiation as recorded by the radiometers, with the major contribution being from the large volume of flame spreading out from the windows.

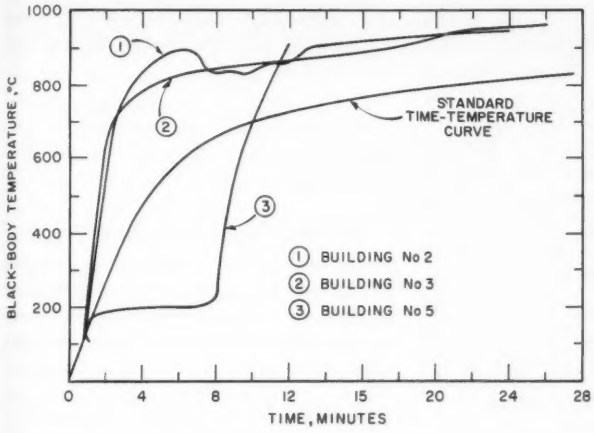


Figure 3. Black-body temperatures, combustible linings.

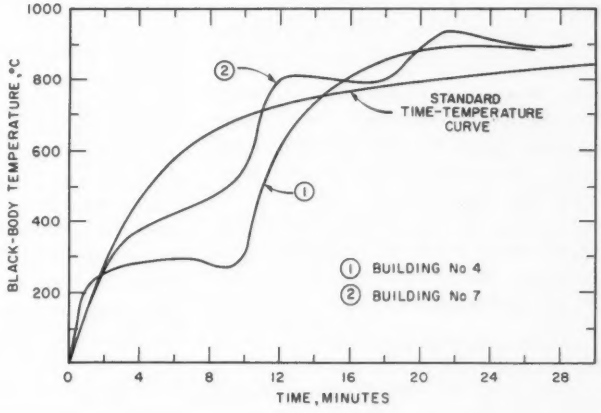


Figure 4. Black-body temperatures, noncombustible linings.

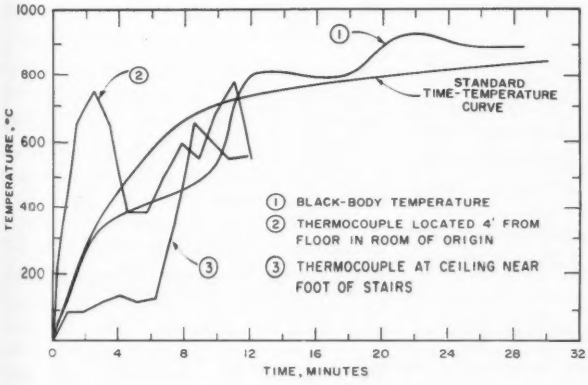


Figure 5. Black-body and thermocouple temperatures, Building No. 7.

Figure 2 gives an indication of the typical behavior of the radiation levels with time. The level of radiation for the buildings with noncombustible linings expressed in terms of I/F never exceeded one quarter of the maximum value of 20 cal/cm²/sec until after 16 minutes from the start of the test. Only in one of the buildings with combustible linings, for which the maximum value of I/F was about 40 cal/cm²/sec, did the radiation level rise above the quarter value within 16 minutes; in house No. 5 with pressed paperboard lining, a quarter of the maximum value was attained in 10 to 11 minutes.

Conclusions from Radiation Measurements

The conclusions to be drawn from the radiation measurements are as follows:

1. The radiation levels from buildings completely lined internally with combustible materials were double those where noncombustible linings were used, the peak levels being about 40 cal/cm²/sec and 20 cal/cm²/sec respectively, when expressed as hypothetical radiation intensities, I/F, over the window areas alone.

2. The hypothetical window radiation intensity, I/F, is a convenient and useful factor by which the radiation levels from different buildings can be compared.

3. The contribution of radiation directly from the openings in the exterior walls (at the periods of peak radiation) was substantially less than that from the flames above and surrounding the windows, the former being no more than about 3.6 cal/cm²/sec, compared to the maximum hypothetical window radiation levels, I/F, of 20 cal/cm²/sec, and 40 cal/cm²/sec.

4. A period of at least 16 minutes elapsed before maximum radiation levels were attained.

5. Maximum radiation levels were not greatly affected by the type of exterior covering.

6. Radiation levels were affected by wind conditions, but the results obtained were not adequate to allow a quantitative analysis of the effects.

Internal Temperature Conditions

The black-body temperature records of the dwelling tests are given in Figures 3 to 5. It is useful to compare these results with the furnace time-temperature curve prescribed in the Standard Methods of Fire Tests of Building Construction and Materials (NFPA No. 251; ASTM E119-58) for the fire resistance testing of structures.[6] Two of the curves relating to houses with combustible linings (Figure 3) are almost identical in form but lie about 150°C (270°F) higher than the standard time-temperature curve. In the case of building No. 5 there was a slight delay before the curve rose sharply; shortly after this, measurements had to be discontinued. From the trend of the curve, it would appear that high black-body temperatures were later attained. For the two houses with noncombustible linings (burns Nos. 4 and 7, Figure 4) the black-body temperatures remained substantially below the standard time-temperature curve values for about 10 minutes and then rose above them.

Considering only the heat transfer to the interior walls of the dwellings, the radiation intensity within the building as defined by a black-body temperature is probably the most appropriate quantitative measurement of the "intensity" of the fire that is capable of simple definition. This presupposes that for walls in the dwellings the heat transfer by convection was very much smaller than that by radiation. For the ceilings, however, it is probable that the heat transfer by convection was very

much greater than for the walls, and so the black-body temperature alone may not give such an adequate measure of the fire intensity for them.

A number of thermocouples were installed throughout the houses. A typical set of temperature records is given in Figure 5. One of the curves (2) refers to a thermocouple located 4 feet from the floor in the room of origin and the other (3) refers to a thermocouple at ceiling level at the foot of the stairs. It will be seen that the temperatures are not directly related to time.

The results for the larger buildings are given in Figure 6. This shows that there was considerable delay, particularly in the case of the Community Hall, before substantial black-body temperatures were attained. During the course of the Community Hall test, the pyrometer measurement was faulty; unfortunately the only results obtained were for the period from zero to 18 minutes when the black-body temperature was still very low and for the period 34 to 35 minutes. In each building two thermocouples were installed 15 feet apart on a beam which had originally constituted a first-floor joist. The thermocouple temperature records for each test were in quite close agreement; one curve only has been drawn for each case. The rapid drop in temperature in each burn after about 18 minutes is believed to be due to the collapse of the supporting beam; these sections of the records should not necessarily be taken as indicating that there was a sharp drop in temperature at the original level of the thermocouples.

Ventilation

The anemometer readings were taken to provide information upon which estimates might be made of the air supplied to the fire, that is, the ventilation rate. One of the specially constructed instruments was placed in the opening formed by partially raising the lower sash in the first house burn. The back

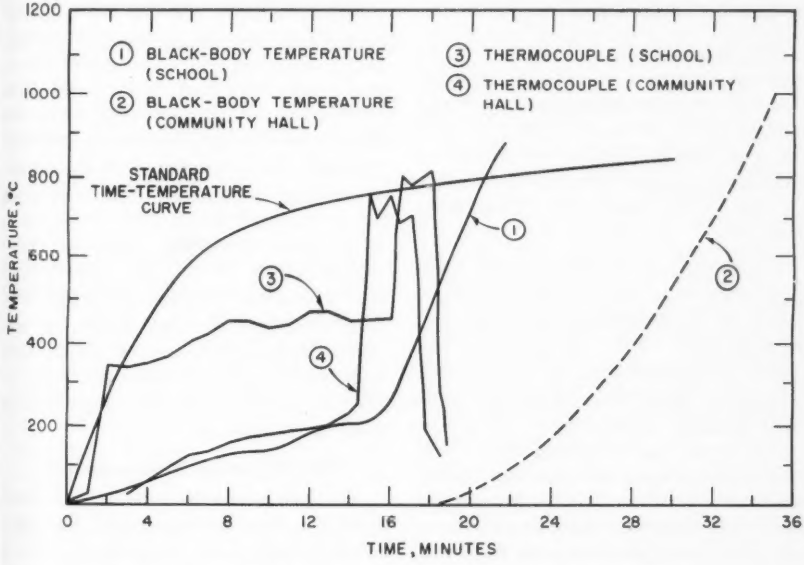


Figure 6. Black-body and thermocouple temperatures, large buildings.

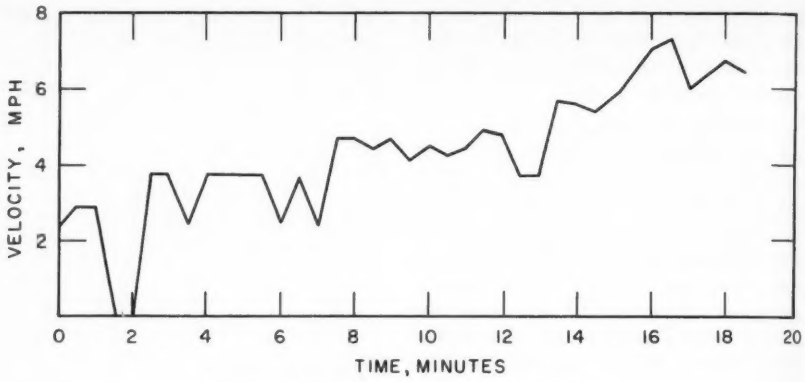


Figure 7. Inlet air velocities: school, main building.

door of the house was also open. The results obtained during the burn were inconclusive since it was possible to leave the instrument in place only for the first 10 minutes of the fire. The readings ranged from negative values to a maximum velocity of 4.5 miles per hour. Other measurements indicated that the fire did not reach its peak until at least 20 minutes had elapsed.

The results were also complicated by the existence of a variable wind up to 6 miles per hour, the effects of which could not be separated from the inlet air speed induced by the fire alone. A somewhat similar situation existed in the case of the burn of the Community Hall.

When the school was burned there was little wind and it was possible to leave the anemometers in position until the fire was fully developed. One anemometer was located in an open window of the main hall and another in an open window of the annex. Both were on the west side of the building. The lower sash of each window was opened about one-third and at the start of the fire there were no other windows or outside doors open; windows were progressively broken as the fire developed. The results are given in Figure 7. On the assumption that the gas temperature within the building was 1000°C, an application of Bernoulli's Theorem gives approximate values of 7.8 miles per hour and 16 miles per hour for the cases where the areas of open or broken windows at the inlet and outlet levels are respectively equal and much greater at outlet than inlet. When the measurements had to be discontinued all the upstairs windows and most of the downstairs windows had fallen out. The higher theoretical value was then not directly applicable; some value between the two was appropriate to the conditions then obtaining. The maximum value recorded, about 7 miles per hour, is in good agreement with the theoretical value. Having thus established that air speeds through openings, and thus ventilation rates, might be predicted from simple theory for at least some of the cases of major interest, no further analysis of the anemometer readings was made.

Miscellaneous Measurements

The noise recordings were compared with the level of the sound emanating from a ringing alarm clock situated 3 feet from the sound level meter. The

Table V
Noise Levels

	Frequency range cps	
	60 to 20,000 cps	600 to 20,000 cps
Fire noise, open door, average	69 db	67 db
Fire noise, open door, peak	72 db	72 db
Fire noise, closed door, average	65 db	55 db
Fire noise, closed door, peak	67 db	58 db
Alarm clock, ringing	—	63 db

results are listed in Table V. The last column has been included because it is believed that it is the noises in the higher frequency range that will most probably awaken a sleeping person. Table V shows that the higher frequencies are attenuated much more than the lower frequencies by the closing of the bedroom door. If the noise of an alarm clock would arouse a sleeper, the fire noise would have awakened the occupant of a room with the door open. There is some doubt whether a person would have been awakened in a bedroom with the door closed. The sharp crackling sounds produced from the start of these fires may not be typical of a dwelling fire but may have been associated with the nature of the igniting cribs.

The film records of some of the burns were studied to provide information on the pattern of flame from windows and on the horizontal and vertical distances to which flame patterns extended. Flames extended up to 18 feet horizontally in the case of burn No. 5, the maximum distance outward being reached at about the height of the house. The maximum extension horizontally was about the same, 17 feet, in the case of burn No. 7, occurring at a level just below the eaves. The extreme limit of flame in the case of the Community Hall was about 25 feet, at a height of about half that of the building itself. During the School burn, flames extended to a distance of 18 feet at about eave level.

Conclusions

The tests had three major objectives, the conclusions regarding each of which can be summarized as follows:

1. With reference to the survival of occupants, it was found that all dwellings became smoke-logged within 6 minutes of the ignition of the cribs. In all but one case the criterion for decrease of visibility was exceeded before the other criteria for survival — the carbon monoxide concentration, reduction of oxygen, and temperature. The smoke criterion relates principally to possible unaided escape of occupants in contrast to the lethal effects of carbon monoxide and high temperatures, upon which survival depends more directly and without regard for subsequent rescue. The relation between the limiting times, according to the respective criteria, is shown in Table II, and, excluding the visibility criterion, is summarized in Table III.

2. Extensive studies of radiation were a major feature of the test and valuable information on radiation levels was obtained. The conclusions are listed in the section dealing with radiation levels (see page 308).

3. Limited information on air speeds through open windows was obtained in the case of one of the larger buildings. The maximum value obtained provides a reasonable check on estimates based on simple theory.

Time-temperature relationships were obtained for the fires in all buildings. These provided an interesting comparison with the standard time-temperature curve. In the case of two of the three

dwellings lined with combustible materials, the black-body temperatures developed in the room of origin of the fire exceeded for about 30 minutes the values given by the standard time-temperature curve.

Interesting information was obtained on the noise level in a bedroom produced by a fire downstairs which would not necessarily rouse a sleeping occupant of an upstairs bedroom with the door closed.

A useful photographic record of all fires from the time of ignition has been obtained, and from this it has been possible to estimate the projection of flame fronts from the windows.

Acknowledgments

The success of the operation was made possible by the very valuable cooperation of a number of organizations including the Hydro-Electric Power Commission of Ontario, the Ontario Fire Marshal's Office, the National Film Board, and the Ontario Provincial Police. Grateful acknowledgment is due to all the members of the Fire Section and to other members of the Division for untiring efforts, often under extremely difficult circumstances.

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Gas Industry Appliance Testing

By Frank E. Hodgdon

Director, American Gas Association, Inc., Laboratories

As the gas industry's "appliance proving grounds," the American Gas Association, Inc., Laboratories are internationally known for their contributions to the safe design of gas appliances. The A.G.A. Laboratories have achieved this recognition through their effective administration of the appliance approval program. This program of industry self-regulation is designed, basically, for safety of appliance operation, but it also provides minimum standards for such usage factors as appliance efficiency and serviceability. Through this program, the user of approved gas appliances is afforded a major degree of protection from the menace of destructive fires and other forms of hazard which might affect life and property.

While no statistics are available as to the number of fires and other forms of hazards which have been prevented as the result of the Laboratories' activities, the annual figures of the National Fire Protection Association indicate that less than 3 per cent of the known causes of building fires in the United States were attributed to gas and gas appliances. These figures give no breakdown of the fires attributed to gas appliances alone, and, furthermore, no separation is made between approved and nonapproved appliances. It appears reasonable, therefore, to assume that only a fraction of the fires that are reported were caused by the use of A.G.A. approved gas appliances and accessories.

Approval Program

A major portion of the excellent safety record attained by the gas industry may be attributed to the effectiveness of this appliance approval program administered by the Laboratories as a function of the American Gas Association.

Under the A.G.A. Laboratories' plan, prototype models of gas appliances are furnished on a voluntary basis by the manufacturer. An extensive and impartial examination of the construction

and performance of the unit is then made by the appliance testing engineers to ascertain whether or not the model fully complies with the industry's published national minimum specifications covering the safety, durability and performance of the unit. Any manufacturer of gas appliances or any manufacturer of accessories for use on gas appliances,

The Laboratories' Approval Seal

whose product is found to comply with the industry's published minimum standards, following the Laboratories' complete examination, is then authorized to display the Laboratories' registered Approval Seal on each appliance, or the Laboratories' Listing Symbol in the case of an accessory, produced in conformance with the model tested.

Although the construction and performance of a gas appliance may exceed the published minimum requirements, display of the Laboratories' Approval Seal signifies that the appliance fully complies with the industry's minimum standards. Through this unique voluntary program of self-regulation on the part of the gas industry, the confidence of the appliance buyer, city authority, insurance underwriter, gas utility, and others interested in the safety and performance of approved gas equipment is achieved. This confidence, undoubtedly, has been a major reason for the growth and acceptance of the gas industry in the U. S. A. during the last three decades.

Need for National Testing Agency

Prior to the advent of the industry's appliance approval program and the organization of the A.G.A. Laboratories in 1925, some local gas utilities and governmental authorities had developed, on a limited scale, specifications covering the safety, performance, and installation of gas equipment. Preparation of the specifications and their enforcement, however, was a local matter and, from a national viewpoint, was not adequate nor economical. Furthermore, the multiplicity of local specifications proved burdensome to equipment manufacturers marketing on a national scale.

While the need for a centralized testing agency was under consideration as

The Laboratories' Listing Symbol

early as 1903, it was not until 1924 that the industry's leaders strongly recommended to the then newly formed American Gas Association that a national gas appliance testing agency be established on behalf of the industry.

The wisdom of establishing the A.G.A. Laboratories and the value of the services rendered is reflected in their growth. Starting in small rented quarters with a staff of four, the Labora-

tories have since expanded into their own modern and fully equipped buildings with headquarters at Cleveland, Ohio. In 1931, branch facilities were established at Los Angeles, California. The present facilities have a combined floor area of about 90,000 square feet and a staff of over 200 people, composed mainly of engineers qualified in appliance testing procedures, gas technology and the engineering sciences. It is estimated that over 50,000 models of gas appliances and accessories have been tested by the Laboratories. At present, approximately 5,000 basic models of appliances and accessories are tested and certified annually for over 500 equipment manufacturers. The Laboratories represent an investment of over $1,500,000 in buildings, gas piping, and specialized testing equipment, but more important is the 35 years of staff experience in approval testing and gas technology.

Nonprofit Operation

The A.G.A. Laboratories are a nonprofit appliance testing and research organization dedicated to the safety and welfare of the gas appliance user. They are organized to perform five basic functions: (a) appliance approval testing, (b) field inspection of certified equipment, (c) standards preparation, (d) requirements investigation, and (e) utilization research. All of these functions are interrelated in the problem of preventing fires from gas appliances.

Inasmuch as the industry's appliance approval program is a voluntary program, any gas appliance or accessory manufacturer may voluntarily elect to have his equipment examined and tested by the Laboratories for compliance with the industry's national standards. However, under the Laboratories' established policy, only those gas appliances and their related accessories for which published minimum American Standard Requirements are available, may be accepted for certification.

Fees for the actual examination services rendered to the manufacturer support the approval testing and field inspection operation. Funds for publishing the approval and listing requirements and funds for investigational studies are derived from the Association. Utilization research to advance the knowledge and art of the industry is financed and performed under a program sponsored by the American Gas Association. One aim of the A.G.A. program of promotion, advertising, and research is to acquaint the public with the importance of buying A.G.A. Laboratories' Approved appliances and accessories.

Standards — Hub of Activities

Important to the over-all operation of the Laboratories and the success of the appliance approval program is the preparation of adequate and up-to-date approval and listing specifications. The industry's minimum requirements are the center around which the Laboratories' activities revolve. Before the manufacturer is authorized to display the Laboratories' Approval Seal on his appliance or the Listing Symbol on an accessory, the Laboratories must satisfy themselves that the construction and performance meet the industry's standards in every respect.

As the provisions of the standards are continuously under review, the industry's approval and listing standards are prepared under the supervision of a number of subcommittees which report to the Approval Requirements Committee. Membership for these groups is selected from widespread geographical areas and consists for the most part of representatives from gas utilities and manufacturing organizations. Representatives from a number of general

interest and consumer groups, such as the National Fire Protection Association, American Petroleum Institute, Federal Housing Administration, The Liquefied Petroleum Gas Association, and others are included.

The Approval Requirements Committee, in preparing the industry's national requirements, directs the activities of the subcommittees and takes final action on all requirements and revisions prepared. This group is also a Sectional Committee of the American Standards Association, Inc. Through this means the industry's requirements become American Standards.

American Standards have been prepared for some 32 different types of gas appliances and accessories. These include the usual household domestic appliances, such as gas ranges, built-in cooking units, water heaters, clothes dryers, room heaters, incinerators, refrigerators, central heating equipment and summer air conditioning absorption type units. Standards are also available for the major commercial cooking units such as deep fat fryers, hotel and restaurant ranges, portable bake ovens, and a number of commercial countertype units. In the gas accessory field, standards have been developed for such items as gas valves, automatic pilots, pressure regulators, relief valves, thermostats, conversion burners and other components which are used with or form a part of a gas appliance. Although the industry's requirements should not be construed to be a blueprint for product design, their provisions are published for the full information of the industry and the guidance of others interested in the scope of the examination given certified gas equipment.

Fact Finding Behind Requirements

Since the requirements are prepared by representatives of the industry, the Laboratories' role in their preparation is basically clerical and advisory. Arrangements for the necessary committee meetings and other details are handled by the Laboratories. In addition, the Laboratories conduct extensive requirements investigations on request of the Approval Requirements Committee and the subcommittees to assist in the preparation of approval provisions based on a sound scientific approach.

Throughout the last three decades, it is estimated that over 500 requirements investigational studies have been made for the guidance of the industry's committees. This work included extensive studies to determine proper limitation of temperatures of appliances and surrounding structure to assure freedom from hazard, as well as accuracy of measuring methods and appropriateness of the test procedures specified. These studies also include investigation of combustion efficiency, safety and operating control performance, application of electrical wiring and electrical components used on gas appliances, strength and selection of materials, burner and pilot operating characteristics, and other facets of a varied and challenging nature.

Test Gases

Extensive studies have been made by the Laboratories to determine the types of fuel gases and gas pressure used for testing purposes. At present, seven types of fuel gases are specified in the requirements. These test gases are natural, mixed and manufactured gases, 3200 Btu per cubic foot butane, 2500 Btu per cubic foot propane, and 1400 Btu and 525 Btu per cubic foot butane gas-air mixtures. The use of these test gases together with the variations in test pressures applied during testing makes it possible to duplicate during the Laboratories' examination the per-

formance conditions likely to be encountered in service.

Production Quality Checked

Important to maintaining a high standard of safety from fire is the periodic inspection of appliances and accessories by the Laboratories at the source of production.

Figure 1 shows a Laboratories Field Inspector checking the assembly of a gas water heater at a production point.

Visits are made once a year to every manufacturer's production facilities to examine each model of approved equipment, and at other times during the year at unannounced intervals. The manufacturer, in order to maintain certification on his approved or listed units, must at all times comply with the applicable American Standards under which his product was approved and must manufacture in accordance with the Laboratories' records of the prototype models originally tested. In addition, the manufacturer is required to maintain quality control over his production.

Approval granted on a gas appliance is valid for the remainder of the calendar year in which the appliance is approved. Approval may be renewed by factory inspection on an annual basis for five consecutive years. At the end of the five year approval period, the manufacturer may seek reapproval under the latest American Standard in effect at the time, if production of the model is to be continued.

Directory of Approved Appliances

For the information of the industry, the manufacturer's name and model number of his approved appliance is

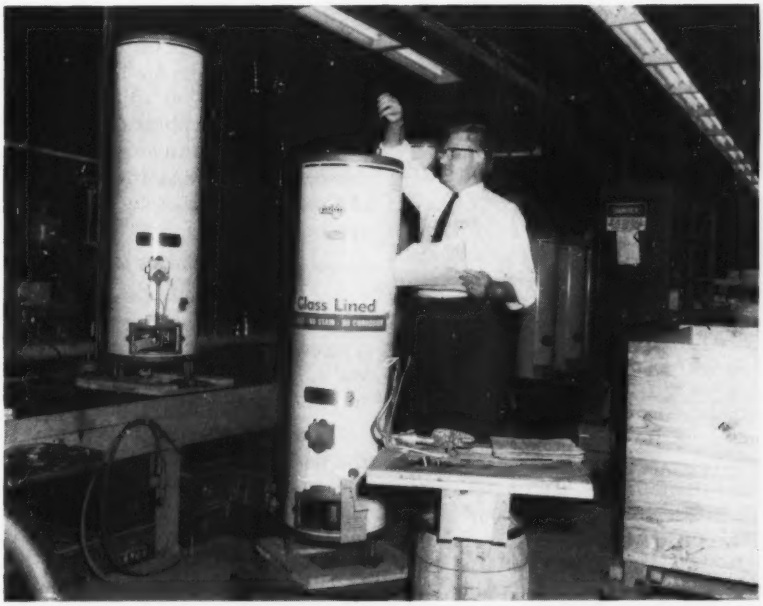


Figure 1. An A.G.A. Laboratories inspector checking for production quality of a gas water heater at a manufacturer's plant.

published in the Laboratories' Directory of Approved Appliances and Listed Accessories. This Directory includes information on the standard clearances or the approved reduced clearances at which the unit may be installed.

The A.G.A. Laboratories' Directory is extensively used by gas utilities, inspection bureaus, and others since it lists all approved appliances and listed accessories of current production. It is published in complete form for January and July, with supplements issued for the intervening months. Annual subscriptions are available at $2.00 each.*

The absence of a listing in the current Directory should not be construed that an earlier model was not authorized to display the Approval Seal at the time it was produced. Only appliances of current production are listed. Previous authorization to display the Approval Seal on an appliance model no longer being manufactured may be verified by consulting the listings of previous issues of the Directory.

Utilization Research

While the Laboratories research activities are directly related to projects of benefit to the advancement of the gas industry, various phases of the research in many instances are related to the protection of life, limb, and property.

A typical example is the extensive research study made by the Laboratories on domestic gas incinerators. Although this study was aimed at the elimination of smoke, odors, and fly ash from gas incinerators, it was necessary to perform extensive research on the burning of highly combustible dry materials in order to prevent runaway combustion together with excessive heat releases and excessive temperatures. The published findings of this research have resulted in major improvement in the design of contemporary gas incinerators.

To date, over 135 research bulletins and reports have been published of major benefit to the industry in the solution of many complex problems. This research has likewise been instrumental in the development of the safest and most efficient forms of heat-producing gas equipment to be found in service.

Safe Appliance Fundamentals

In preparing national standards under which the design of gas appliances and accessories are appraised, the industry's committees recognize that any appliance model likely to provide unsafe conditions would be undesirable. Thus, fundamental to all of the American Standards for gas appliances and accessories, are detailed provisions and test procedures to prevent any hazard which could result by the use of inadequate gas equipment in the field. These provisions include details for the prevention and protection from fire hazard, including temperatures on adjacent combustible materials, application and dependability of operating and protective control systems, and the temperatures of flue gases released by approved gas appliances.

Temperature of Combustible Materials

For each type of gas appliance for which standards have been developed, temperature limitations are specified for walls, floors, ceiling, or enclosures surrounding the appliance.

Tests are conducted to determine that the temperatures on surrounding structures do not exceed the maximum permissible with the appliance properly installed and operating at the manufacturer's specified input rating. For ordinary conditions, a 90°F rise in temperature from approximately a 70°F room temperature is acceptable on adjacent

*Available from the American Gas Association, Inc., Laboratories, 1032 East 62nd St., Cleveland 3, Ohio.

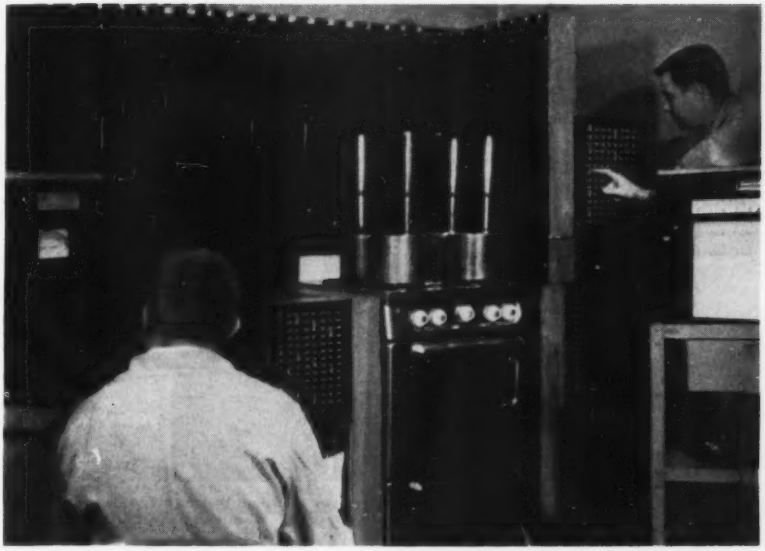


Figure 2. A free standing domestic gas range undergoing a temperature limitation test on adjacent wall and floor surfaces.

surfaces. In fact, the temperature limitations specified in the standards provide an ample factor of safety to preclude the possibility of danger of fire.

A typical free standing flush-to-wall type domestic gas range being subjected to the fire hazard test at the Laboratories is shown in Figure 2. For this fire prevention test the gas range has been installed in the Laboratories' wall and floor temperature test board having vertical wall surfaces set at right angles. The walls of the test board are constructed of one-inch thick wooden boards finished in flat black for maximum heat absorption. The back wall is six feet high. The side walls are adjustable so that the side pieces may be aligned even with the cooking top and front of the range, and may be extended to six feet in height when necessary. The floor of the test board is made of one-inch tongue-and-groove oak flooring finished with clear varnish. Temperature measurements are made by means of thermocouples installed flush to the surfaces.

Under this test setup, the appliance is operated for an extended period of time under stringent operating conditions as specified in the standards so as to determine that the appliance will not create a fire hazard when installed on the user's premises.

Wall and floor temperature tests similar in nature to the test described for the free standing domestic ranges are also applied to room heaters, water heaters, clothes dryers, and a number of other household type units.

With the advent of the built-in type of gas appliance, which is normally installed in contact with combustible materials, it became necessary to employ a test enclosure exactly simulating the intended installation on the user's premises.

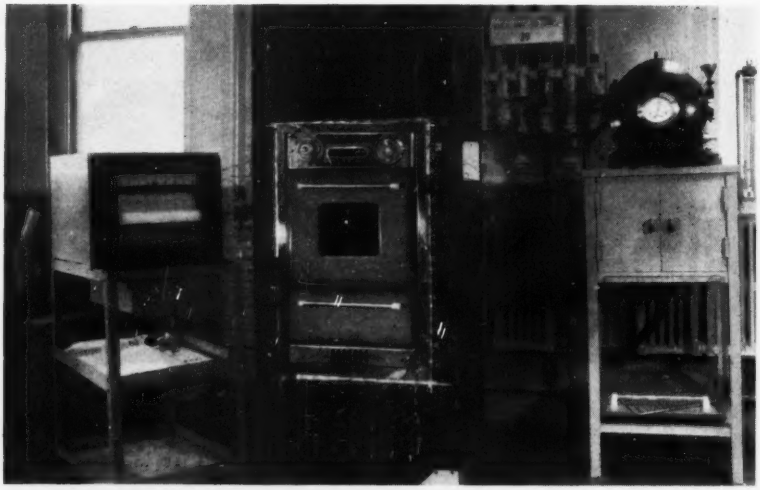


Figure 3. The development of built-in gas ranges installed in contact with combustible materials necessitated new test methods to assure freedom from fire hazards.

Figures 3 and 4 show typical cabinet construction used for the testing of a built-in top section cooking unit and for testing a separate oven section. These cabinets, made of wood and painted dull black on the inner surface, have thermocouples which pass through the enclosure wall so that they are held in contact

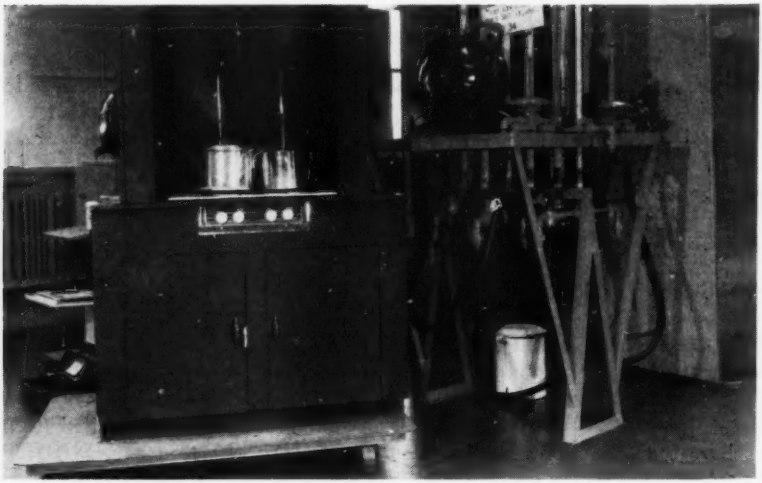


Figure 4. Test setup to determine temperatures on adjacent cabinet construction around a built-in domestic top section.

with the inner surface by means of thin transparent tape.

As in the case of free standing appliances, the built-in type unit is operated for an extended time to assure that the temperature of the enclosure will not exceed the temperature limit permitted.

Another example of the comprehensiveness of the approval tests for fire prevention is illustrated by the test applied to forced air central furnaces designed for closet or alcove installation.

A typical setup for a closet test is shown in Figure 5. From Figure 5, it will be noted that a forced-air central furnace has been installed in a closet made of combustible materials having dull black painted wood inside surfaces studded with temperature-sensitive thermocouples. At the option of the manufacturer, a clearance of 0, 1, 2, 3, or 6 inches may be selected between the walls of the test enclosure and the closest portion of the unit, except for the draft hood. In the case of the draft hood or draft hood relief opening, a clearance of at least 6 inches is required between the walls and ceiling of the enclosure for both the draft hood relief opening and the nearest point of the draft hood exterior. While the ceiling of the test enclosure is normally 7 feet, 6 inches high, the furnace manufacturer may specify the clearance from the top of the furnace to the ceiling for furnaces with integral plenums and for horizontal type furnaces.

In all cases, appliances tested for closet installation must display permissible minimum clearances on a permanent marking plate.

From Figure 5, it will be noted that the door of the enclosure has two openings which are important to the proper operation of the appliance. One opening is located in the upper part of the door to provide for ventilation of the enclosure. The lower opening provides a means of entrance for fresh air into the closet for efficient combustion of the fuel gas, draft hood dilution air, and for ventilation air. Each opening is sized on the basis of 1 square inch free area for each 1000 Btu per hour of gas input of the appliance.

Temperatures attained on the inner surface of the closet when the furnace is operating under these installed conditions are determined by the test applied and are not to exceed the limit specified by the approval requirements. Important to fire prevention are a number of

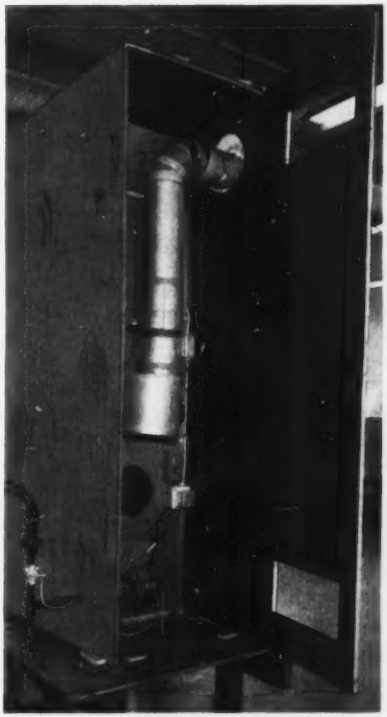


Figure 5. A forced-air central furnace for closet installation is tested to determine the proper clearance from combustibles. The dull black painted wood is to assure maximum heat absorption and the thermocouples measure the radiated temperatures.

additional tests which are applied to determine enclosure temperatures with the appliance operating under conditions simulating (a) power failure, defective motor or blower, (b) a blocked cold air return, and (c) stoppage of the warm air outlet. Tests under these abnormal conditions are performed to assure proper operation of the protective control devices built into the appliance and which limit the enclosure temperature to a safe value.

Approved Clearances

For optimum safety in the field, a gas appliance must be installed in accordance with the conditions of approval and local codes or regulations.

For the information of the appliance installer, inspection authorities and others, the manufacturer of appliances approved for reduced clearance installation is required by the Laboratories to include in his installation instructions and on the appliance the approved minimum clearances. Appliances approved for installation with so-called "standard clearances" are to be installed in accordance with the clearances specified in the NFPA Standard for the Installation of Gas Appliances and Gas Piping (No. 54) or American Standard Installation of Gas Appliances and Gas Piping (ASA Z21.30), which are identical in their technical provisions. The manufacturer's installation instructions are reviewed by the Laboratories to assure accuracy and compatibility with the test results. Any field installation of an approved appliance at a lesser clearance than that used during the approval tests at the Laboratories may result in unsatisfactory conditions.

Dependability of Control Systems

The approval requirements stress dependability and proper application of all operating and protective control devices used on appliances, and these are believed to be of prime importance as a fire prevention measure. To assure dependability and faithful performance of accessory control devices at all times, whether it is a control that acts frequently or one that responds only upon an emergency, substantial and durable construction is demanded. Furthermore, the application of controls on the appliance must be properly engineered into a system that will provide the degree of protection intended.

The accessory listing standards have been prepared to provide for many years of trouble-free service of control devices and specify compliance with extended life tests before the design of the control is accepted. In some cases, for example, the control is required to withstand 100,000 cycles of operation without exhibiting evidence of failure or breakdown.

Extensive research by the A.G.A. Laboratories has provided the framework for many of the remarkable improvements in the construction and performance of appliances and component devices. Research in the fundamentals of appliance technology and in the development of a "yardstick" by which to measure acceptance, has stimulated industry research.

Hazards from the escape of unburned fuel gas and subsequent ignition have virtually been eliminated by the use of automatic pilots on modern gas equipment. These automatic pilots will shut off the gas supply in the event the means of main burner ignition becomes inoperative. Their use on modern gas equipment represents a major step forward in automaticity and fire prevention.

Automatic pilots, for example, as the result of industry research will operate more rapidly to close off the gas supply in the event of pilot flame outage than was considered possible a few decades

ago. Furthermore, automatic pilots employing inferior design, construction and materials have been eliminated from the modern gas appliance by the stringent performance provisions outlined in the current listing standards for automatic pilots. Similar advancements could also be cited for other types of control devices and their application to appliances. These would include thermostats, gas valves, temperature and pressure relief devices, pressure regulators, fan and high temperature limit controls and others.

In addition to the mechanical safeguards required, tests are performed to determine satisfactory burner flame travel, combustion efficiency, ignition characteristics and scores of other tests to check for safe operation, durable construction and satisfactory performance.

Flue Gas Temperatures

Another important point in the prevention of fire is the limitation of flue gas temperatures imposed on vented gas appliances. The test procedure used for determining the temperature of the flue gases from a domestic gas water heater is a typical example of the comprehensiveness of the approval standards in this respect.

For gas water heaters, the temperature of the flue gases is measured at the flue outlet of the water heater proper and prior to dilution with cool air entrained through the relief opening of the draft hood. Nine individual temperature readings are made in order to determine the average flue gas temperature. The temperature of the flue gases so measured shall not exceed 550°F.

In view of the stringent specifications and test procedures required by the approval standards for flue gas temperatures, the national installation standard for gas appliances, NFPA No. 54 (ASA Z21.30), permit the use of Type B gas vents to vent approved gas appliances, except for domestic gas incinerators, vented recessed heaters and gas appliances having sealed combustion chambers.

In the approval testing of the domestic gas incinerator, it must be recognized that in field service, the incinerator is subjected to wide variations in the composition, heating value, moisture content and amount of material to be incinerated. It produces heat from combustible waste materials placed in the incinerator by the user and not primarily from the gas supplied. The design of an approved gas incinerator, however, must be such that the burning of highly combustible dry materials will present no fire hazard from runaway combustion. This is achieved by limiting the air to the refuse and then supplying ample air in most cases during the after-burning process for smoke elimination.

During approval tests the incinerator is installed in the Laboratories' wall and floor temperature test boards and connected to a flue. An incinerator having a vertical flue outlet is placed with the sides 12 inches from the side walls of the test board and flue pipe spaced 18 inches from the rear test wall. In the case of an incinerator having a horizontal outlet, the side and rear are placed 12 inches from the test wall and a suitable horizontal flue pipe installed to carry the products of combustion through the rear test wall.

For this test a charge of dry shredded newspaper, proportioned on the basis of one pound per bushel of rated incinerator capacity is used. This charge is introduced into the incinerator chamber intermittently at 8 minute intervals and continued for seven successive charges. The temperature of the walls and floor of the test board are measured during the burning on the seventh and eighth

charge. In no case is the temperature on the combustible surfaces to exceed 90°F in excess of room temperature when measured by bead-type thermocouples.

The temperature of the flue gases discharged from a gas incinerator is also measured during the fire hazard test. In this case, a flue gas temperature in excess of 1400°F at any time is not considered acceptable. A further limitation is also imposed on the temperature of the flue gases discharged. During the course of test to determine the incinerating effectiveness, flue gas temperatures are continuously recorded and are not to exceed 1000°F for any period in excess of 15 minutes per charge and in no case to exceed 1400°F. A typical charge, composed of a mixture of 40 per cent dry combustibles and 60 per cent food refuse, is used under a loading schedule extending over a 96-hour period.

Domestic gas incinerators are required to be vented into chimneys (Paragraph 5-2-3. of NFPA No. 54). However, NFPA No. 54 (ASA Z21.30), Paragraph 5-2-7. permits metal pipe not less than No. 20 U. S. Standard gage galvanized iron or other equivalent noncombustible, corrosion-resistant material to be used for the venting of a gas incinerator installed in locations such as open sheds, breezeways, or carports, provided the metal pipe is exposed and readily examinable for its full length and suitable clearances are maintained.

In the cases of vented recessed heaters, NFPA No. 54 (Paragraphs 5-2-5. and 4-8-1.) specifies the use of listed Type B-W gas vents when installed within combustible 2 inch by 4 inch stud wall construction. Since a vented recessed heater is normally designed to be vented vertically through a limited enclosed studding space, special test wall structures are used for test purposes by the Laboratories which are constructed in a manner to simulate a field installation of a vented recessed heater. The manufacturer is required to furnish for test purposes the full 8 foot ceiling height consisting of appliance and vent system.

Gas appliances employing a sealed combustion chamber having integral venting and which are so constructed and installed that all air for combustion is derived from outside the space being heated and all flue gases are discharged to the outside atmosphere are considered as being properly vented when they are installed in accordance with their listing and the manufacturer's instructions.

Summary

In this article the basic operations of the A.G.A. Laboratories have been described together with a few of the tests applied to gas appliances to prevent the menace of fires. The tests that have been cited are typical of the comprehensive test procedures specified by the industry's national minimum standards for gas appliances and accessories to provide for safe operation, durable construction, satisfactory performance and long life of trouble free service. From a review of the standards it will be fully apparent that those gas appliances which display the Laboratories registered "Blue Star" Approval Seal have successfully complied with the highest standards of safety.

Following is a list of American Standard approval, listing, and installation requirements for gas appliances and accessories:

Approval Requirements

American Standard Approval Requirements for Domestic Gas Ranges, Z21.1
Volume I (Z21.1.1) Free Standing Units
Volume II (Z21.1.2) Built-In Domestic Cooking Units

American Standard Approval Requirements for Hotel and Restaurant Gas Ranges and Unit Broilers, Z21.3

American Standard Approval Requirements for Domestic Gas Clothes Dryers, Z21.5

American Standard Approval Requirements for Domestic Gas-Fired Incinerators, Z21.6

American Standard Approval Requirements for Domestic Gas Hot Plates and Laundry Stoves, Z21.9

American Standard Approval Requirements for Gas Water Heaters, Z21.10
Volume I (Z21.10.1) Gas Water Heaters
Volume II (Z21.10.2) Side-Arm Type Water Heaters

American Standard Approval Requirements for Gas-Fired Room Heaters, Z21.11

American Standard Approval Requirements for Central Heating Gas Appliances, Z21.13
Volume I (Z21.13.1) Steam and Hot Water Boilers
Volume II (Z21.13.2) Gravity and Forced Air Central Furnaces
Volume III (Z21.13.3) Gravity and Fan Type Floor Furnaces
Volume IV (Z21.13.4) Gravity and Fan Type Vented Recessed Heaters

American Standard Approval Requirements for Gas Unit Heaters, Z21.16

American Standard Approval Requirements for Refrigerators Using Gas Fuel, Z21.19

American Standard Approval Requirements for Hotel and Restaurant Gas Deep Fat Fryers, Z21.27

American Standard Approval Requirements for Portable Gas Baking and Roasting Ovens, Z21.28

American Standard Approval Requirements for Gas Counter Appliances, Z21.31

American Standard Approval Requirements for Gas-Fired Duct Furnaces, Z21.34

American Standard Approval Requirements for Dual Oven Type Combination Gas Ranges, Z21.37

American Standard Approval Requirements for Gas-Fired Absorption Summer Air Conditioning Appliances, Z21.40

Listing Requirements

American Standard Listing Requirements on Gas Hose for Portable Gas Appliances, Z21.2

American Standard Listing Requirements for Draft Hoods, Z21.12

American Standard Listing Requirements for Manually Operated Gas Valves, Z21.15

American Standard Listing Requirements for Domestic Gas Conversion Burners, Z21.17

American Standard Listing Requirements for Domestic Gas Appliance Pressure Regulators, Z21.18

American Standard Listing Requirements for Automatic Pilots, Z21.20

American Standard Listing Requirements for Automatic Valves for Gas Appliances, Z21.21

American Standard Listing Requirements for Relief Valves and Automatic Gas Shut-Off Devices for Hot Water Supply Systems, Z21.22

American Standard Listing Requirements for Gas Appliance Thermostats, Z21.23

American Standard Listing Requirements for Metal Connectors for Gas Appliances, Z21.24

American Standard Listing Requirements for Furnace Temperature Limit Controls and Fan Controls, Z21.29

American Standard Listing Requirements for Gum Protective Devices, Z21.35

American Standard Listing Requirements for Gas Conversion Burners for Domestic Ranges, Z21.39

Installation Requirements

American Standard Installation of Domestic Gas Conversion Burners, Z21.8

American Standard Installation of Gas Appliances and Gas Piping, Z21.30
(Standard for the Installation of Gas Appliances and Gas Piping, NFPA No. 54, NBFU No. 54)

American Standard Requirements for Installation of Gas Equipment in Large Boilers, Z21.33

American Standard Requirements for Installation of Gas Conversion Burners in Domestic Ranges, Z21.38

EDITOR'S NOTE

Underwriters' Laboratories, Inc., tests gas appliances also, but they cover primarily the commercial and industrial gas and combination gas-oil boilers, burners, furnaces, and heaters. Underwriters' Laboratories, Inc., also tests accessories for gas appliances, such as safety controls, ignition systems, electric valves, transformers, etc. Such appliances and some of the accessories are listed in the Laboratories' Gas and Oil Equipment List. Additional accessories are listed in the Electrical Construction Materials List.

The Chemical Aspects of Fire Extinguishment

By Arthur B. Guise, Ansul Chemical Company

Member, Society of Fire Protection Engineers

As a result of fairly recent and not too widely publicized research, our understanding of how fire extinguishing agents work has increased greatly. This new understanding in turn may lead to more effective provision for the control and extinguishment of fires.

Before discussing the action of the various fire extinguishing agents (water in various forms and combinations, halogenated hydrocarbons, carbon dioxide, and dry chemical powders) the nature of fire itself must be briefly reviewed. Here, too, research is producing new understanding that is basic to any discussion of how fires are extinguished.

The old familiar fire triangle concept which postulates that fire can exist only when heat, fuel, and oxygen are present is really an oversimplification. In the light of new findings it must be refined to a new fire square, if you will. In this new fire square, heat, fuel, and oxygen remain, but a new factor, a chemical chain-reaction in the flame itself, is added as a fourth essential to the exist-

Based on a paper presented by the author before the American Chemical Society at their Annual Meeting in Atlantic City, September 16, 1959. An edited version of this paper appeared in the November 1959 issue of *Industrial and Engineering Chemistry*, page 73A (Volume 51, Number 11), copyright 1959 by the American Chemical Society and reprinted here by permission of the author and the copyright owner.

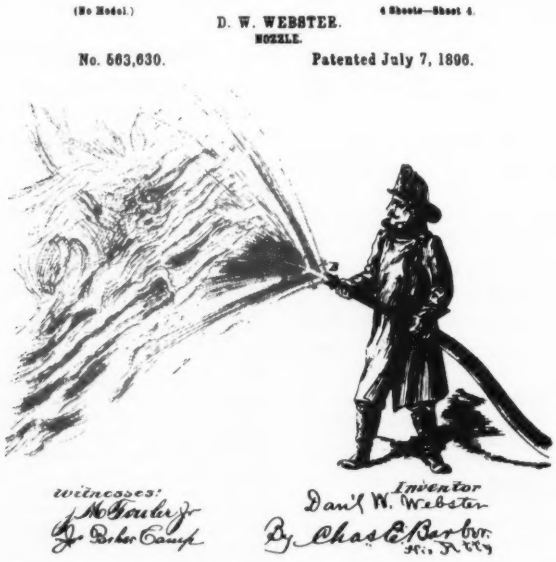


Figure 1. Reproduction of patent application for an early American water nozzle invented by Daniel W. Webster in 1896.

ence of fire. Consequently, in fire extinguishment, an additional dimension has been included in the old fire fighting formula of remove the fuel, remove the heat, or remove the oxygen. It may be simply stated as "interrupt the flame chain-reaction."[4] Research indicates that this action may be extremely important as an explanation of the effectiveness of certain extinguishing agents.

Water and Water Solutions

With this modern concept of fire itself in mind, let us now consider the action of the various extinguishing agents. The most common, oldest, cheapest, and most plentiful of all is plain water, applied to a fire as a liquid stream or as spray (Figure 1). The extinguishing action of plain water is based solely on the removal of heat.[5] The burning fuel is cooled by the water to the point where it no longer evolves a combustible vapor to mix with air and the fire is extinguished.

With one exception, the extinguishing action of water and water solutions is purely physical. Steam acts as a smothering agent by displacement of oxygen, and the mechanical and chemical foams act as blanketing agents to separate the fuel from the air. Wetting agents and viscosity-increasing agents[1] increase the effectiveness of the cooling action of water by retarding runoff.

The first indication of true chemical action in extinguishment where water is concerned is the "loaded stream" solution.[14] This is a solution of potassium carbonate in water with other additives to reduce the freezing point to −40°F and is used in hand portable and wheeled extinguishers. The loaded stream solution is more effective than plain water on fires in ordinary combustibles such as wood, cloth, or paper and is also approved for use on flammable liquid fires where plain water would not be effective even as a spray.

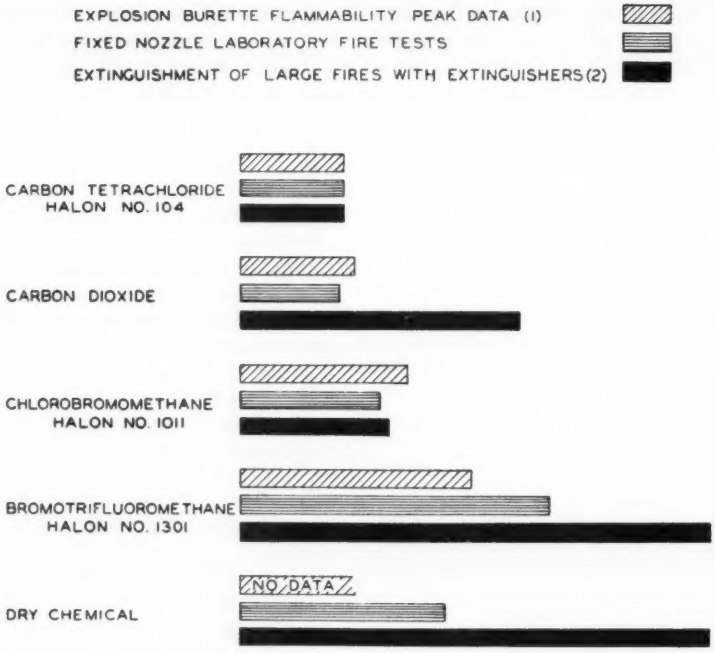
Early work is this area was described by Thomas and Hochwalt in 1928.[13] On the basis of experimental results, they concluded that water solutions of metallic salts based on elements in Group I of the Periodic Table (lithium, sodium, potassium, rubidium, or cesium) were more effective as the atomic weights of the cations increased. They also found that alkali metal salts with anions containing oxygen and halogens were most effective and ascribed the action to a "negative catalytic" effect on the combustion reaction. It is probable that the effectiveness of these solutions is due to a chemical chain-breaking action. This is also indicated by practical experience with the loaded stream extinguisher which is most effective on flammable liquid fires when the solution is applied so as to produce a spray.

Carbon Dioxide

Carbon dioxide, also a very familiar extinguishant, is essentially as simple in its action as water. When introduced into the combustion zone, carbon dioxide dilutes the reactants — oxygen and fuel vapors — below the concentration necessary to support combustion. Carbon dioxide may be used on any type of fire regardless of the type of fuel involved or the presence of electrical hazards. However, confinement is required in the case of fires involving ordinary combustibles to assure effective exclusion of oxygen from the fuel for sufficient time to allow cooling to below reignition temperatures.

Halogenated Hydrocarbons

Much research has been carried out to evaluate the extinguishing effectiveness of a large variety of halogenated hydrocarbons. At one time it was thought that the extinguishing action of these halogenated compounds was due to cooling by vaporization and smothering by vapor dilution of air and



(1) HARRY E. MORAN JR., "DEVELOPMENTS IN FIRE EXTINGUISHERS," SYMPOSIUM ON FIRE EXTINGUISHMENT RESEARCH AND ENGINEERING, U.S.C.E. RES. & EVAL. LAB., NOV. '54

(2) UNDERWRITERS' LABORATORIES FIRE TEST PROCEDURE FOR COMPARATIVE RATINGS OF COMMERCIAL EXTINGUISHERS.

Figure 2. Comparative effectiveness of extinguishing agents on weight basis.

fuel vapors. It is now believed that the major extinguishing mechanism is a chemical chain-breaking action and that the halogens inhibit continuation of the combustion reaction by combining with hydrogen atoms and removing them from the reaction.[3]

Carbon tetrachloride is an easily obtained and inexpensive extinguishant, but its application is declining rapidly. This waning popularity is due to increased attention to the toxicity of the agent and the toxicity of the products of thermal decomposition. Chlorobromomethane developed by the Germans during World War II has slightly less toxicity than carbon tetrachloride and is a more effective extinguishing agent.

Methyl bromide, another well-known halogenated extinguishing agent, gained wide acceptance in foreign countries but has never been widely used in the United States. Its use abroad has also declined, due to toxicity far greater than that of carbon tetrachloride.

New halogenated agents of considerable effectiveness are fluorobromo compounds.[10] One, bromotrifluoromethane (Halon 1301), is receiving concentrated attention from the military but its cost, presently in the neighborhood of $4 per pound, has delayed widespread com-

mercial application despite excellent extinguishing effectiveness and low toxicity.

It must be pointed out, however, that the encouraging results of laboratory evaluation of halogenated compounds must be carefully weighed in the light of actual field application results (Figure 2). There is considerable discrepancy between practical extinguishing results and laboratory evaluation, especially by means of the explosion buret method.

Although the explosion buret method is a convenient way of carrying out preliminary evaluations in the laboratory,[9] it does not represent the actual conditions of fire extinguishment because the values reported are obtained under conditions where the combustion reaction is not already proceeding. Laboratory evaluations on a larger scale by the use of fixed nozzles[7] may be converted to practical applications where properly engineered piped systems with fixed nozzles are being used. Where streams from extinguishers or hoselines must be used, the physical characteristics of the halogenated compounds may impose limitations that do not allow the theoretical effectiveness of the extinguishing agent to be obtained. This is quite clearly shown by Figure 2.

Dry Chemicals

The fourth major type of extinguishing agent is dry chemical. Dry chemical consists essentially of finely divided sodium bicarbonate with additives used primarily to enhance flowing action and water repellency.

Potassium bicarbonate is also under consideration as a dry chemical agent but is not as yet commercially available.[11] Both laboratory and practical evaluations of potassium bicarbonate dry chemical indicate a greater extinguishing effectiveness than sodium bicarbonate dry chemical.

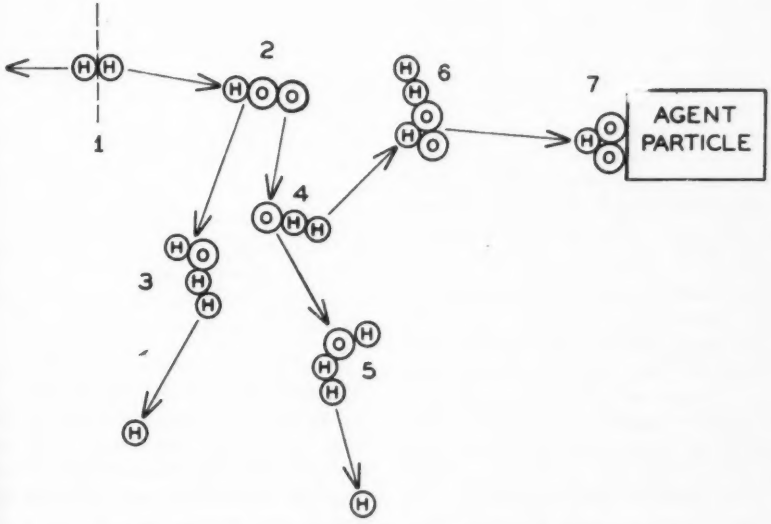


Figure 3. Branched-chain combustion reaction of hydrogen and oxygen.

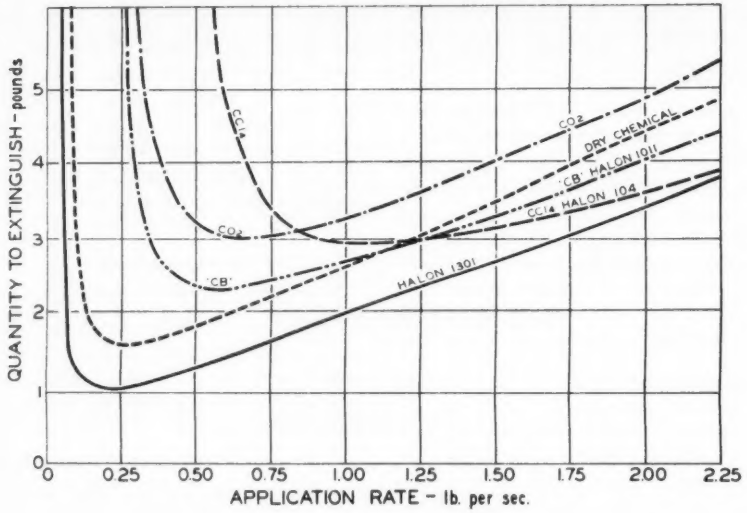


Figure 4. Effect of application rate.

The finely divided chemical is expelled from its container by dry gas (air, carbon dioxide, or nitrogen) under pressure through a nozzle which controls the pattern of application much as water is controlled, but the extinguishing action is quite different. Dry chemical is believed to extinguish primarily by means of chemical chain-reaction interruption.[6] Cooling or dilution of reactants important in all other extinguishants is believed to be a relatively minor factor. Even chemicals not readily decomposed by heat, such as sodium chloride, are effective extinguishing agents when applied as a powder.

The chain-reaction, the new fourth factor essential to the existence of fire as discussed earlier, involves the presence in the flame zone of free radicals. These interact with both fuel and oxygen in such a way as to produce a continuing or increasing supply of free radicals to continue the flame reaction in true chain fashion (Figure 3). A simple hydrogen flame reaction illustrates this point. The free radicals are self-propagating unless captured by condensation on or interaction with some inerting substance. This is believed to be the basis of dry chemical fire extinguishing action. The fine particles introduced to the flame area are believed to capture sufficient of the free radicals to interrupt the chain-reaction and nearly instantaneous flame suppression results.

It is apparent that a cloud of dry chemical therefore is similar to a flame arrestor in that a flame cannot pass through a cloud of particles, when in proper concentration, and conversely when the cloud of particles is produced where the combustion reaction is proceeding, extinguishment takes place.

The effectiveness of dry chemical as a "flame arrestor" is understood when it is realized that it takes in the neighborhood of 200 million particles of dry chemical per cubic foot of flame to extinguish a gasoline fire and approximately two billion particles per cubic foot to extinguish a hydrogen fire.

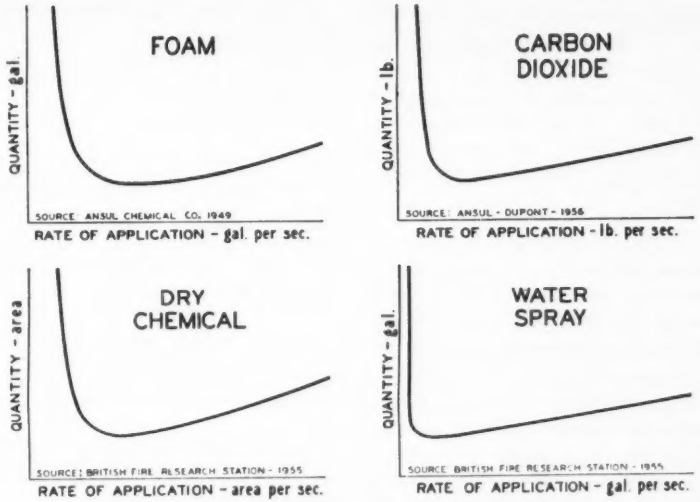

FOAM
QUANTITY - gal.
SOURCE: ANSUL CHEMICAL CO. 1949
RATE OF APPLICATION - gal. per sec.
CARBON DIOXIDE
QUANTITY - lb.
SOURCE: ANSUL - DUPONT - 1956
RATE OF APPLICATION - lb. per sec.
DRY CHEMICAL
QUANTITY - area
SOURCE: BRITISH FIRE RESEARCH STATION - 1955
RATE OF APPLICATION - area per sec.
WATER SPRAY
QUANTITY - gal.
SOURCE: BRITISH FIRE RESEARCH STATION - 1955
RATE OF APPLICATION - gal. per sec.

Figure 5. General applicability of analysis method.

Comparison of Extinguishing Agents

With their various types of extinguishing actions — chemical, physical or a combination of both — all extinguishing agents may be generally compared for effectiveness in terms of the quantity required for extinguishment of a given fire. Figure 4 shows such a comparison. Each curve is derived from extinguishing data and all illustrate an important factor in the effectiveness of any type of agent — rate of application.

In Figure 5 curves are separated to emphasize this point. Note that when rate of application is too low, no amount of extinguishant will control the fire. This is true of all agents.

In the case of dry chemical extinguishing agents with their almost exclusively chemical extinguishing action, wherein the combustion reaction is interrupted, one more factor is vital. This is particle size (Figure 6). Studies indicate that attachment of free radicals to a surface is apparently a basic factor in chain-reaction interruption. The dry chemical particles in the flame zone provide such a surface and the finer the powder the greater the effective surface

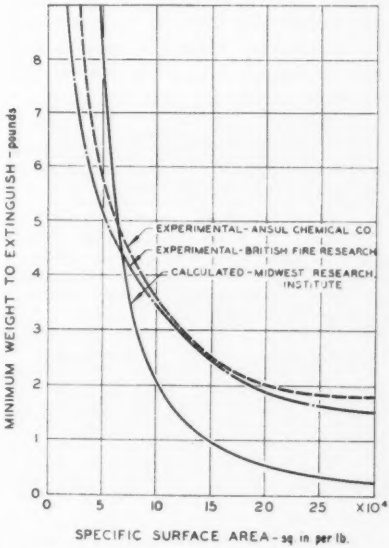


Figure 6. Relation of particle size to extinguishing effectiveness of dry chemicals.

for a given quantity of agent and the shorter the distance of diffusion of a free radical. These curves depict the results of three studies to determine the effect of surface area. Note the general agreement between calculated data[12] and two sets of independent experimental data.[8, 2]

Summary

In summary, our past concept of fire and fire extinguishment must be modernized in the light of recent findings. Actual chemical action to interrupt the flame chain-reaction must be added to fuel, heat or oxygen removal as a basic mechanism of extinguishment.

Within the framework of this new concept four primary types of extinguishing agents function effectively in various ways. Water in its various forms and with various additives extinguishes by cooling or smothering. Carbon dioxide acts by diluting the reactants or excluding oxygen. Halogenated hydrocarbons combine these actions and also introduce chain-breaking capability. Dry chemical apparently functions almost exclusively by interrupting the flame chain-reaction.

Acknowledgment

The author wishes to thank William T. Rohrberg, Ansul Chemical Co., for assistance in the preparation of this paper.

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Fire Prevention Is People

By Gordon H. Eggers
Staff Fire Protection Engineer, Ford Motor Company

Progressive industrial concerns today recognize the need and sound value of good fire prevention and protection. Such items as full sprinkler protection, water supplies of adequate volume and pressure, hourly inplant security patrols during nonoperating periods, and a standard complement of first aid fire-fighting equipment are all necessary requirements for a good program. These private facilities, together with a good municipal fire department, provide essential elements of good *protection*, but, in themselves, afford little in the way of fire *prevention*.

In the broad terminology "Fire Prevention Is People," and in industry, this, of course, means all employees. At Ford, we believe that a good fire conscious attitude of our employees is the primary element in our fire prevention program.

Numerous promotional and educational programs are used to obtain such an attitude. Fire prevention in the home and in the community, in addition to good industrial fire prevention practices, are stressed. We sincerely believe that if we can get the employee thinking about good fire prevention in the home and community, we will receive the residual benefits of this attitude at the plant. Conversely, if he is thoroughly impressed with the importance of good fire prevention in the plant, this attitude will carry over to his home. How then do we go about building the proper attitude of employees toward good fire safe practices?

The Ford Motor Company has adopted the Fire Prevention Week observance each year as our key educational event for fire prevention and use this promotion as a springboard for our year round fire control program. All plants within the company for a number of years have been urged by top management to participate in the Fire Prevention Week activities and to enter the Industrial Division of the Fire Prevention Week contest sponsored by the Fire Prevention and Cleanup Campaign Committee of NFPA. In 1958 thirty-six Ford plants entered this competition and we were very proud when our Los Angeles plant was awarded first place in the industrial division. Five other Ford plants placed in the first twenty awards granted.

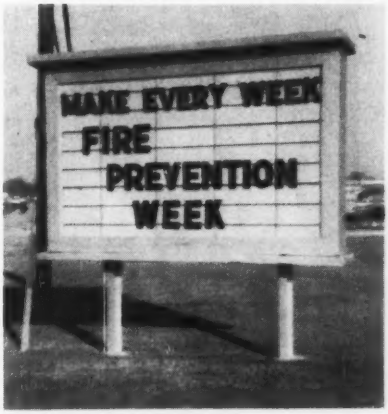


Photo No. 1. Ford uses Fire Prevention Week as a springboard for its year round fire control educational campaign for all employees.

Based on an address by the author at the NFPA Fall Conference held Nov. 11 to 13, 1959, in Des Moines, Iowa.

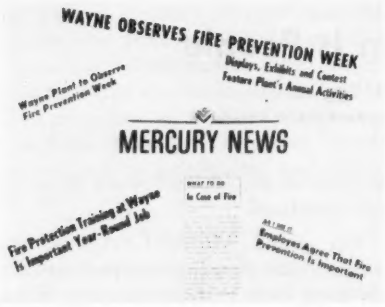

WAYNE OBSERVES FIRE PREVENTION WEEK
Displays, Exhibits and Contest Feature Plant's Annual Activities
Wayne Plant to Observe Fire Prevention Week
MERCURY NEWS
Fire Protection Training at Wayne Is Important Year-Round Job
WHAT TO DO In Case of Fire
Employees Agree That Fire Prevention Is Important

Photo No. 2. Plant newspapers at 28 Ford plants reach 155,000 employee homes with fire prevention messages.

The Fire Prevention Week observance at the plants features many and varied fire prevention and protection activities for the home and at the plant. Fire Prevention Week is widely publicized on plant bulletin boards and signs as illustrated in Photo No. 1.

Within the company we have a total of 28 monthly plant newspapers which are mailed to the homes of 155,000 of our employees. The estimated readership of these publications is about a half-million people Approximately 95 percent of all company employees receive a plant newspaper. The issues before, during and after Fire Prevention Week afford special emphasis to the fire control program. Photo No. 2 shows that home fire safety is equally publicized with the industrial aspects of fire prevention.

A number of methods and devices are used to promote home fire safety during Fire Prevention Week. The following give some examples:

Exhibits in the Plant

Photo No. 3 shows the familiar Sparky with a large bulletin board placed in the plant cafeteria. On one side of this bulletin board Sparky gives advice on fire safety at home. On the other side are listed important industrial fire precautions.

Another exhibit (Photo No. 4) is located at the employee entrance to the plant and is called "The House of Hazards." The signs used in conjunction with the display point out precautions pertaining to careless smoking

Photo No. 3. Fire safety education at Ford plants is directed to the home and the community as well as to the plant. The goal: Establish employee fire prevention thinking! The symbol: Sparky!

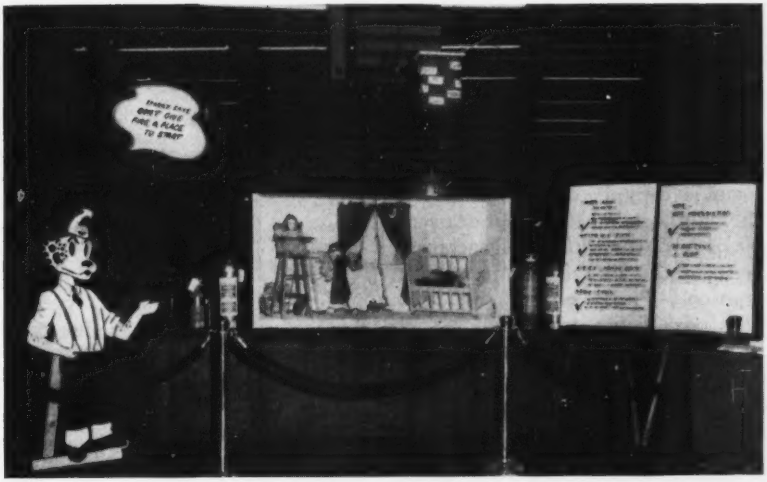


Photo No. 4. This "House of Hazards" illustrates how far Sparky goes at Ford to educate employees on home fire safety principles.

and matches, electrical equipment, use of flammable liquids in the home, hazardous heating equipment, housekeeping, and the TV antenna on the roof. Such exhibits placed at strategic locations in the plants are well received by the employees and vividly illustrate the importance of home fire safety.

Coordination with Local Fire Dept's

The company plants are instructed to work closely with the local municipal fire department. As a result of this cooperation, the local fire department in many cases participates in the plant's fire prevention week activities. Usually these activities consist of an inspection of the plant, demonstrations, combined drills with the plant fire brigade and talks to employees about fire prevention at the plant, the home and in the community. Photo No. 5 illustrates a municipal fire captain explaining their fire apparatus to a group of Ford Fire Brigade members.

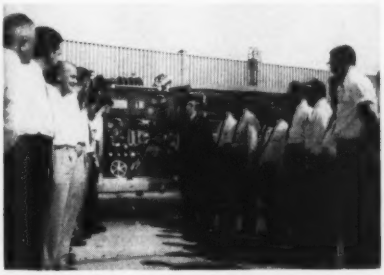


Photo No. 5. Plant Fire Brigade members receive instruction on a municipal pumper.

Photo No. 6. Publicity on fire safety is aided by a Model T and a 1960 Hollywood Model.

Photo No. 6 was taken at our Los Angeles Assembly Plant and shows the Plant Manager and members of the Los Angeles County Fire Department, participating in the observance of Fire Prevention Week.

As the Los Angeles plant is close to the movie capital of the world, the studios also sent one of their stars to assist us in putting life and generating interest in the Fire Prevention Week promotion. Please note the antique Ford Model T fire truck which still looks as if it is in good condition and ready for action.

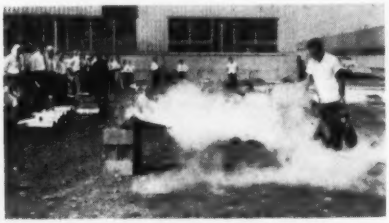


Photo No. 7. Employee handling of fire extinguishers during FPW centralizes attention on the purpose.

Fire Prevention Week at the plant is used as an excellent opportunity for the fire brigades to complete the outdoor portion of their fire training for the year. This training consists of such important items as laying hose, ladder practice, extinguishing various test fires, etc. As part of this program, many hourly and salary employees are given training in the proper use of portable fire-fighting equipment.

Photo No. 7 illustrates a number of employees receiving training in the use of class "A," "B," and "C" extinguishers. This training admittedly covers only the basics of fire protection; however, personnel learn to use the proper extinguisher on each type of fire and this information is of value to the employee wherever he may be, in his home, school, church, department store, or at the corner filling station.

Photo No. 8. "Take-home" literature from information racks includes many NFPA educational leaflets.

During Fire Prevention Week and throughout the year, home fire prevention literature is furnished free of charge to employees by various methods.

Photo No. 8 shows a Ford plant worker examining an employee information rack, filled with fire prevention material. Pamphlets available are:

Your Fire Safe Home
Your Clothing Can Burn
Put That Fire Out
When Fire Strikes You
Know How to Use It

Additional fire prevention and protection material is distributed to employees by plant guards as they leave the premises or is mailed to their homes.

At the Los Angeles Assembly Plant, Fire Prevention Week observance is enlivened, as shown in Photo No. 9, by

Photo No. 9. Some plants are ideally located to use movie stars to distribute fire prevention literature, and somehow this technique appeals to the employees.

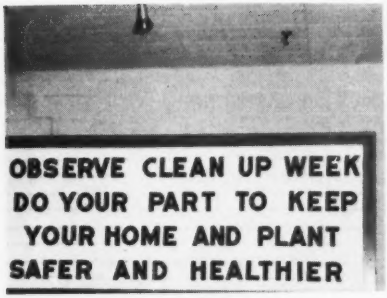


Photo No. 10. A cafeteria billboard, protected judiciously by a sprinkler, calls attention to Clean-up Week.

a Hollywood star who walked around the plant distributing fire prevention literature to employees on the job. Needless to say, none of the workers refused to accept a pamphlet on this occasion.

The Christmas season and the annual Clean-up, Paint-up weeks observed in the spring throughout the country also serve as an opportunity to remind employees of the importance of fire prevention in the home. For instance, Photo No. 10 shows a large sign in the cafeteria of a plant during Clean-up, Paint-up week pointing out to employees that the home and plant are safer and healthier when kept clean.

In addition to fire extinguisher training, cooperation with the local fire department, demonstrations, handouts, pamphlets, and publicity in the employee newspapers, many locations within the Company utilize contests to generate further interest in fire safety by the employee and his family. The Sparky coloring contest is widely used. Slogan and essay contests relative to home and plant fire safety have also proved an excellent stimulus for fire prevention interest. Most plants offer prizes ranging from new fire extinguishers to a Government bond for winners of this competition.

Photo No. 11 shows the 13-year-old daughter of one of our employees with her winning slogan in the Fire Prevention Week contest: FIRE STARTS — WHEN CARE DEPARTS. This simple slogan carries an important fire prevention message which is applicable to the home, industry, and community. The slogan also symbolizes the over-all fire safe attitude which we try to convey to our workers and which we feel pays important dividends to the plant, the community, and the employee himself.

We, as individuals responsible for fire control, can engineer and equip facilities for good fire protection, but "Fire Prevention Is People." What succeeds with people — training, education and personal interest — will succeed with fire prevention.

Photo No. 11. This contest winning slogan by the pretty daughter of a Ford employee emphasizes that fire prevention depends on people.

Salina Journal

The $305,000 fire on Jan. 20 at the unsprinklered J. C. Penney store in Salina, Kansas, was typical of most 1959 large loss experience.

Flames from the basement fire were seen in the first-floor office area by a passerby about 40 minutes after the janitor had left the building for the night. The fire spread steadily up the open stairwell and up damperless air-conditioning ducts to the second story and roof. Fire fighting efforts were hampered by a 2-degree-above-zero, 40-mph wind.

Large Loss Fires of 1959

An NFPA Fire Record Department Study

This study highlights the major fire protection failures of the year. Here are the errors of judgment, here is the equipment that didn't work, here is the planning that was never done. Few fields of endeavor are fortunate enough to have their mistakes so clearly available for review, study and correction.

Statistical Summary

During 1959 there were 410 fires and explosions in the United States and Canada causing losses of at least $250,000 each. Of these, 73 involved losses of $1,000,000 or more. The total loss resulting from the 410 fires was the largest in history, $356,422,500, even though the number of large loss fires in 1959 was 20 less than the record 430 for 1956.

These 410 large loss fires caused 198 deaths (includes 127 aircraft fire fatalities) and 1,049 nonfatal injuries (aircraft injuries not included). This is the fourth consecutive year that the large loss fire death total has dropped (401, 312, 263, 198).

The $356,422,500 loss included $173,262,500 lost in the 331 building fires, $138,990,000 lost in the 47 transportation fires, $38,069,500 lost in the 23 forest fires, and $6,100,500 lost in the 9 miscellaneous fires.

The 410 large losses represented about 0.02 per cent of the total number of fires last year but caused over 25 per cent of the total dollar loss. Because of the effect of the few "large loss" fires on the annual total fire waste and also because of the many inevitable indirect losses resulting from such fires that cannot be measured in dollars, they have been carefully analyzed each year by the Fire Record Department of the NFPA and the results published in the QUARTERLY.

Geographical Distribution

Two hundred and eighty-nine of the 331 large loss *building* fires occurred in the United States, 42 in Canada. States with the greatest numbers were Pennsylvania with 32, New York 22, Michigan 21, California and New Jersey 19 each, Illinois 16, Maryland and Texas 9 each. In Canada, the Province of Ontario had 18 large loss building fires, Quebec 8, and British Columbia 5.

Occupancy Distribution

The following table shows the number of large loss fires in the years 1955–1959 by occupancy classification. The total number of fires in 1959 was a substantial increase over 1958 but was less than in 1956 and 1957.

No. of Large Loss Fires by Years

	1959	1958	1957	1956	1955
Industrial	113	85	125	117	78
Mercantile	89	81	58	53	50
Storage	54	43	55	50	41
Residential	17	10	17	24	9
Miscellaneous	90	82	101	94	68
Transportation	47	55	66	92	70
Totals	410	356	422	430	316

The only 1959 decrease was a 16 per cent drop in large loss transportation fires. The increases were led by a 150 per cent gain in large loss church fires (4 to 10), a 70 per cent gain in residential fires, a 30 per cent gain in industrial fires, a 23 per cent gain in storage fires, an 11 per cent gain in the "miscellane-

ous" classification and a 10 per cent gain in mercantile fires (5th year of continuous increase).

Cause of Fires

There were approximately 1,000,000 *building* fires in the U. S. and Canada in 1959. Each of these fires was caused by something or someone, but only 331 became large losses. It is obvious therefore that the cause of a fire is not a factor in its becoming a large loss.

For the record, however, the following information is given on causes of large loss building fires. Of the 1959 large loss building fires, 57.5 per cent were reported with known or probable causes. This percentage has been rising fairly steadily since 1953. This trend may reflect a greater awareness of the importance of investigation of all factors of large loss fires.

The table on this page indicates the most common of the large loss building fire causes.

Definition of "Large Loss"

A total direct fire loss, to buildings, stock, machinery and other tangible assets, of over $250,000 is defined as a "large loss" for the purpose of this analysis. The total direct loss is the sum of the *insured* and *uninsured* direct losses.

Every large loss fire involves serious indirect losses. Most of these losses however cannot be readily measured. Business interruption, rental and other *insured* indirect losses, where known, are shown in Table II, page 418.

Though every effort has been made to determine the actual loss in each case, the loss figures given should be considered approximate rather than actual.

Principal Large Loss Building Fire Causes by Number

Cause	1959	1958	1957-1953
Electrical Fires	58	54	112
Fixed services, fires due to misuse, or faulty wiring, equipment.	45	41	77
Power consuming appliance failure	13	13	35
Incendiary, Suspicious	28	24	67
Heating and Cooking	26	27	64
Oil fired equipment defective or overheated	5	10	11
Gas fired equipment defective or overheated	9	3	3
Other equipment defective or overheated	8	3	12
Chimneys or flues defective or overheated	3	5	17
Combustibles near heaters	1	6	21
Smoking and Matches	21	15	33
Flammable Liquids	9	12	56
Appliances, incl. lamps, blow torches, etc.	2	1	6
Miscellaneous other flammable liquid fires	7	11	50
Cutting and Welding	8	15	45
Lightning	5	4	28
Miscellaneous Known Causes	35	40	147
Total Known Causes	190	191	552
Per Cent of Total Building Fires	57.5%	66.8%	40.9%
Undetermined Causes	141	95	795
Total Building Fires	331	286	1,347

This Year's Large Loss Study

The 1959 large loss report is arranged to highlight the factors responsible for large loss fires. Occupancy factors, where important, are covered in the NFPA Occupancy Fire Records.*

The large loss fire report consists of a series of articles dealing with the significant features of the *building* fire experience followed by separate articles on the "Large Loss Fires Not in Buildings," and on "Large Loss Aircraft Fires." Summaries of fires are included to illustrate significant factors.

Each large loss fire is the result of a combination of factors. While a report on a particular fire may appear as an illustration of one factor, the write-up on each fire is intended to show all the major factors which were involved in the particular loss.

The series of articles on the large loss building fires cover the following subjects:

	Page
Time, Place and Origin of Fire	346
Detection of Fire	349
Alarm of Fire	356
Spread of Fire	359
Private Fire Protection	377
Public Fire Protection	389

Table I, at the end of the discussion of large loss building fires, indicates the important factors responsible for large loss fires in recent years.

The report on "Large Loss Fires Not in Buildings" (page 403) describes fires involving property outside of buildings with separate reports on forest fires and transportation fire experience (other than aircraft).

Since aircraft and missile fires continue to take a toll of over 25 per cent of the total annual large loss, they are separated into an article of their own for special study.

The 1959 large loss fire report ends with Table II, a record of all large loss fires grouped by occupancies. Fires that have been written up as illustrations can be located by use of the Index to Volume 53 starting on page 440 of this issue. Fires appear in the Index under the occupancy headings utilized in Table II.

Acknowledgment

This study is based on reports submitted by many individuals and agencies. The fire reports so submitted are in many cases the result of extra time and effort. They often include special drawings, plans and photographs. They may be the result of hours of investigation and writing. It is to the people who submitted these reports — the fire chiefs, the fire marshals, the inspectors, the insurance industry and the NFPA members who have given of their time — that this large loss story is dedicated, for without their support and interest there would be no story.

*See NFPA list of "Publications on Fire Prevention and Protection" for data on these Records.

1959 Large Loss Building Fires —

Time, Place and Origin of Fire

Time of origin has an influence on the large loss experience. A recent review of fire department annual reports shows that 58 per cent of alarms for all fires occur between the hours of 6 A.M. and 6 P.M. and 42 per cent for the other 12 hours. The study of large loss fires reverses this picture since 58 per cent occur in the 6 P.M. to 6 A.M. period.

The lightest period for all types of fire alarms noted in the previously mentioned review was between midnight and 6 A.M. when only 11.7 per cent of the alarms were received. Conversely, the midnight to 6 A.M. period was the heaviest for large loss fire alarms, as 31.8 per cent of the fires were discovered between these hours.

These reversals show clearly the influence of delayed discovery (see Article on Detection of Fire) and occasionally the effect of nefarious nighttime operations, such as burglary and arson.

Place

The physical size of the town involved, its population and its total wealth seem to have little to do with the large loss experience. The factor that appears to be important is the frequency with which large values are exposed to fire without adequate fire protection. (See article on Private Fire Protection.) As long as such values are left unprotected and exposed, there will be large loss fires.

Origin

Multistoried buildings were the scene of 186 large loss fires. Seventy-nine of these were in multistoried buildings without basements, 107 in multistoried buildings with basements. The remaining 145 large loss building fires occurred in 1-story buildings, only 26 of which had basements.

Floor of Origin

Two hundred large loss fires started on the ground floor, 53 in basements, 46 on the upper floors, 10 in the attic, 6 in spaces under the building, 3 on the roof and 5 fires spread inside from the outside. The remainder started in unknown areas of the buildings. For information on how these fires spread see pages 359 to 376.

Jan. 29, North Sydney, N. S., Leonard Bros., Div. of National Sea Products Ltd. 1 killed; $493,500

Fish Processing, Storage and Packing. At 4 A.M. one of the two employees of this ¾-acre fish plant noticed a well-advanced fire on the third floor level of the 3½-story smoke room. The fire spread rapidly and easily through the plant, which was filled with wooden and cardboard boxes, as there were no fire divisions to stop its spread. Fire department access to the plant was limited by wire fencing and railroad tracks.

Since the fire department of this town of 7000 could not be expected to handle a fire of this size, a call went out for mutual aid assistance. The fire chief of the mutual aid town of Sydney Mines was killed when he slipped and struck his head during the fire fighting operations.

Mar. 6, Indianapolis, Ind., Pilgrim Laundry, et al. $329,500

Laundry. When the last employees left the laundry at 8 P.M. they smelled smoke but concluded it was from a trash fire outdoors and did not call the fire department. Three hours and forty-five minutes later a passerby saw a brisk fire in the packaging department in the front of the unsprinklered 1-story masonry, wood-joisted building and called the fire department. As soon as firemen opened the front door flames spread rapidly.

Cause of the fire could not be definitely determined, but the laundry owner believes it was caused by spontaneous heating of rubber-backed cotton rugs that had been wrapped while still hot from drying.

April 18, Calais, Me., Northeast Industries $250,000

WOOD NOVELTY MANUFACTURE. Fire originating very early Saturday morning in or near a sprinklered sawdust bin adjoining this old ½ acre, 1- and 2-story wooden woodworker spread into the plant through a large, open loading door nearby. The sprinkler piping was over sixty years old, and the pendent sprinklers may have been obstructed. The heat from the fire sweeping into the building opened many sprinklers.

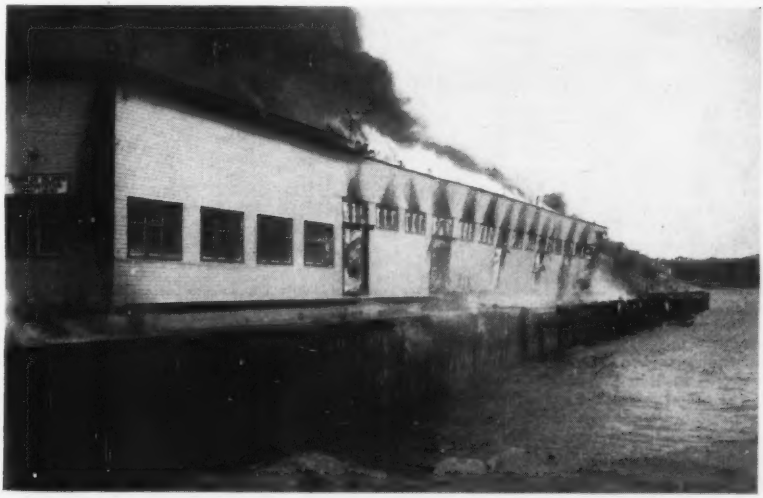
On arrival the fire department of Calais (population, 5000) found that the sprinklers were not holding the fire. Since there was no connection to the sprinkler system all water drafted from the city mains had to be used for hose streams. So much water was eventually pumped that a vacuum developed in the main which collapsed the boiler at the city hospital several blocks away.

July 6, Pictou, N. S., Magdalen Island Transport Co., Ltd., et al. $1,680,000

TERMINAL WAREHOUSES AND PIERS. After two Pictou piers had been destroyed by a July 14, 1946, fire, wise voices called for fire-resistive construction as the town could scarcely afford another shutdown of its important shipping facilities. These words of wisdom were ignored as was NFPA Standard No. 87, "Standard for the Construction and Protection of Piers and Wharves."

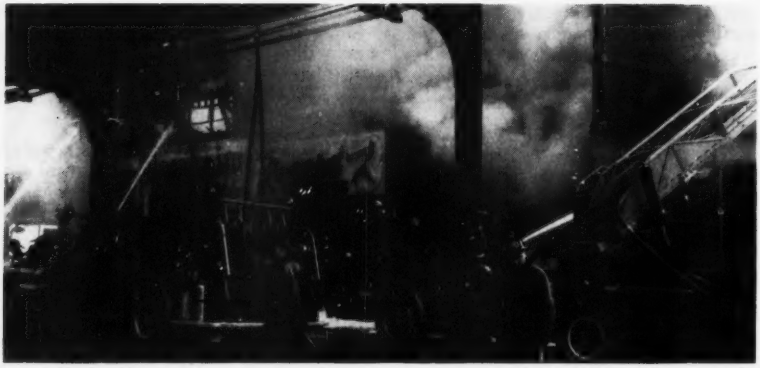
It took years to replace the destroyed piers. Creosoted wooden pilings were used for replacement and no underpier or wharf fire-stop walls were constructed. No underpier sprinklers were installed. To make matters worse a concrete layer was laid over the decking. Even removable plugs, so often spaced over the decking for quick insertion of cellar pipes and rotating nozzles, were not installed. Closely spaced plank fenders cut off effective use of hose streams.

It is not surprising then that 13 years later an underpier fire of undetermined cause starting in mid-afternoon at the water end of the pier should sweep before the 35 mph wind to destroy the entire waterfront installation including areas undamaged by the 1946 fire. Manual fire fighting and salvage attempts were impossible with the biting creosote-filled smoke which sent 12 fire fighters and 3 civilians to the hospital for treatment. An 850-ton passenger and freight ship had steam up before the fire was discovered and was able to escape, but a ferry, five fishing boats and buildings on both piers were destroyed. Also destroyed were three buildings in a nearby shipyard.



R. H. Sherwood

Fire at Pictou, Nova Scotia, July 6, 1959



Drennan Photo Service

Large cities have more opportunities for large loss fires than do small towns, but the economic loss to the community is felt much greater in the less populated areas. New York City shrugged off the effect of this Jan. 15, $725,000 multi-store fire with little more than a momentary mention in the press. The fire was discovered by patrolling police in an alley behind a radio shop at 7:02 A.M. The 4-alarm fire burned through a door into the store and burned through floors and up partitions to gut the 3-story masonry, wood-joisted building.

United Press International

That the lack of proper building design and protection can lead to death and destruction is illustrated by this $1,045,000 fatal fire, June 20. The use of proper fire protection techniques is especially valuable in areas removed from public fire protection such as this one (Township 136, 20 miles north of Brainerd, Minn.).

On discovering fire in the first floor kitchen at 5:15 A.M. two night employees hurried through the unsprinklered 12,000 sq. ft. 2-story wooden Breezy Point Lodge pounding on guest room doors. Many of the approximately 75 guests were trapped in their rooms as smoke rapidly filled corridors and open stairways. They jumped, slid down ropes or bed sheets or came down ladders thrown up by hotel employees. Of the at least 24 that were injured, two died. The two victims were a 75-year-old man who jumped from the second story and his wife who lost her grip while sliding down a rope.

1959 Large Loss Building Fires —

Detection of Fire

Detection of fire is the first step in the fire control operation. Detection can occur in a variety of ways, but in order for the alarm to be given someone or something must detect the fire. Ideally detection should occur simultaneously with ignition of the fire.

Of the 331 large loss building fires, 25.7 per cent (85) were detected immediately. Delayed detection was a factor in the other 74.3 per cent (246).

Detection Record

The initial detection of the fire was made in 129 cases by outsiders or passersby, in 126 by occupants or employees, in 23 by an explosion, in 19 by police, in 16 by watchmen, in 3 by automatic fire alarm equipment, in 2 by burglar alarm equipment, and in 3 by automatic sprinkler equipment. In the remaining 10 fires, detection was made by miscellaneous or unreported means.

Sept. 20, Nelson, B. C., South Nelson Elementary School $285,000

ELEMENTARY SCHOOL. Wishing "to give the kids a holiday," a nine-year-old boy entered the 3-story brick, wood-joisted school on Sunday afternoon and lit some papers in a first-floor classroom. It was 3½ hours after the match was lit before the fire was noticed by a neighbor. By then flames had spread over oil-soaked floors and combustible fiberboard interior finish and the fire was out of control. Inadequate manpower, poor water pressure, and difficult access to the hillside building prevented the fire department from saving any of the building.

Renovation costing $200,000 three years before the fire did not include the installation of a sprinkler system or removal of combustible interior finish.

Al Haight

On April 20, a roofer was working with his torch on the copper eaves of this church in Westphalia, Mich. The heat from the torch ignited the dried roof joists and the fire spread quickly throughout the concealed attic spaces. Detection was delayed for approximately 10 minutes as the fire was burning out of sight of the roofer.

While the fire department attempted to bring the fire under control, the parishioners worked to strip the church of all movable items. It took twelve men to move the pulpit out. The fire, having a firm hold on the inaccessible attic section, burned the unsprinklered church to the ground.

A newspaper article lists the improvements made in the $400,000 church building since it was erected 89 years ago, including several major structural changes to insure that the building would remain standing. It is significant that not one of these items was the installation of an automatic sprinkler system.

Operating Status

Of the 331 large loss building fires in 1959, 210 occurred when the building was not occupied or occupied only by watchmen or janitors. Discovery was delayed in 91.9 per cent (193) of the fires in these buildings. Seventy-two fires occurred in buildings which were fully occupied (shifts working, classrooms full, etc.), and discovery was delayed in 29.2 per cent (21) of these.

Forty-seven buildings were occupied partially (maintenance crew or office staff on hand), and in 63.9 per cent (30) discovery was delayed. One of the 2 remaining buildings was idle or vacant (not in use at all), and the status of the remaining building was not reported. Delayed discovery occurred in both of these.

March 18, Athens, Ga., Gulf-Atlantic Warehouse Co. $650,000

Wade Saye

COTTON WAREHOUSE. An employee was repairing the flooring of this sprinklered cotton warehouse in mid-afternoon of a normal working day. A lift-truck operator was working nearby. The employee saw flames in the cotton nearby. Yelling to the driver he threw a bucket of water on the flames and ran to give the alarm over the office intercom. The flames spread rapidly as air hissed from the dry pipe sprinkler

United Press International

When smoke was seen filtering into classrooms of this fully occupied Bristol Township, Pa., High School, the building fire alarm was rung and all 1200 students filed out safely. One teacher reports seeing flames coming from the ceiling shortly after smoke was noticed.

Originating in a basement wall or ceiling space, the $900,000 fire spread through nonfirestopped walls and above suspended combustible acoustical tile ceilings before discovery by teachers in first story classrooms.

Defective wiring in a basement laboratory was the probable cause of the Feb. 2 fire that destroyed one wing of the 1-story brick, wood-joisted U-shaped building.

system and the employees threw more buckets of water.

The responding fire fighters found the 1-acre, 1-story warehouse section heavily involved with smoke and some flames. The fire doors in the parapeted and T'd fire wall between the section of origin and the adjoining section had already been closed. Instead of drafting from the public water system and supporting the sprinklers by pumping into the private water system, fire fighters laid hose lines from the private water system. When it was noticed that water-pressure for hoses was low, as it would be with all sprinklers operating, the decision was made to shut off sprinklers so that hose streams would be better. This exactly wrong decision made it certain that the large warehouse section could burn to the ground. The fire wall with a 5-foot parapet and a 20-foot T cracked but did not fail — and thus prevented complete building destruction.

Lack of Detection Means

The lack of private fire protection of the type designed to assure prompt fire detection was by far the largest factor in the delayed discovery of fire. In 80.5 per cent (196) of the 243 cases of delayed discovery, there was no private detection system in the form of automatic sprinkler systems, automatic fire detection systems, or watchmen.

May 31, San Francisco, Calif., Jefferson School $343,000

ELEMENTARY SCHOOL. The length of time fires can go undetected in buildings without automatic sprinklers or automatic fire alarm systems is shown clearly in this case.

A 12-year-old boy started a fire in the principal's office on the second floor of the

Modesto Fire Department

The lack of any means of detection let fire spread extensively through this 140 ft. by 530 ft. 1-story metalclad, wood-joisted Army field ration packing plant in Modesto, Calif., on Nov. 26 before flames were seen by an off-duty police officer. The officer, some distance from the building, drove to the area and, thinking the fire department was on its way, waited a short while for it to arrive. When no engines did show up, he drove five blocks to the fire headquarters to report. His alarm was received just two minutes before an automatic fire detection system in an exposed building also sent in an alarm (9:03 P.M.).

The $562,000 fire points out the basic cause of most large loss fires: leaving the premises without any form of protection or detection. Had the combustible building been equipped with a complete automatic sprinkler system this Thanksgiving Day, fire would have been detected promptly and probably extinguished before fire fighters could have arrived. Had there been a complete and supervised automatic fire alarm system it is possible that fire fighters might have been alerted in time to halt the fast spreading flames in the cardboard carton and wooden pallets before the fire had spread out of control.

Kitchener-Waterloo Record

With no automatic sprinkler system to detect and extinguish the fire or no automatic fire alarm system to detect the fire, this 7,500 sq. ft. masonry, wood-joisted church burned until a passerby happened to see flames from the street at 1:50 A.M. The sparks pictured above were caused by the collapse of the top 35-foot section of the 85-foot steeple.

The Nov. 1st fire forced this Waterloo, Ont., church board to find another location for the planned Thanksgiving ceremony of burning the mortgage from the $175,000 remodeling, six years previously. It was too bad the remodeling did not include automatic fire protection, which might have delayed the mortgage burning two or three years, but would have assured the parishioners of a place in which to burn it.

unsprinklered 21,000 sq. ft. 3-story combustible building at about 7:00 P.M. The boy had a previous record of setting fires and in this instance resorted to this means of destroying his spelling test paper.

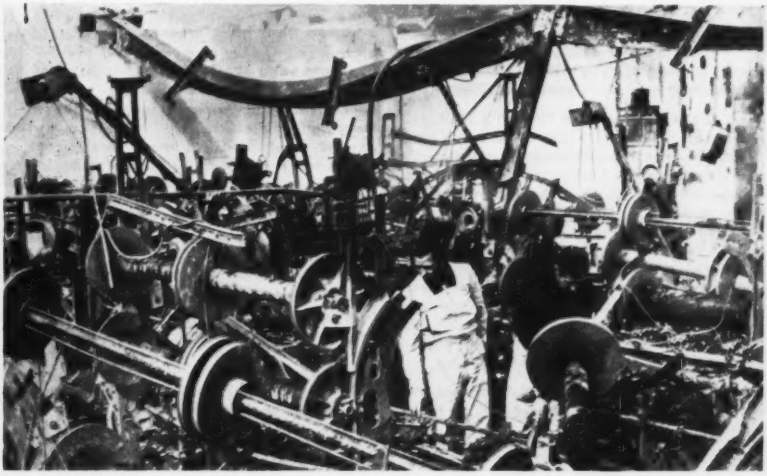
At 5:20 A.M. a service station attendant heard an explosion at the school and gave the alarm. When firemen arrived they found that the fire had burned through the ceiling of the principal's office to the third story and had entered the first story when a filing cabinet fell through the fire-weakened office floor. Fire also spread through nonfire-stopped wall and ceiling spaces.

Watchman

There were 64 large loss fires in buildings having watchmen service. In 6 of these cases the service was satisfactory since the watchman discovered the fire and transmitted the alarm with no delay. In 27 fires the watchman service was not a factor as the fire was discovered promptly by other means, such as by occupants (21), by explosions (5) and in one case by an unreported means.

In 31 fires the watchman service did not function effectively to provide prompt detection. In 16 of these cases the watchman did discover the fire, but not until after an appreciable delay, while the remaining 15 were not discovered by the watchman but by other means. It is interesting to note that 12 of these failures occurred in buildings which were protected by watchmen making standard hourly rounds. The 19 remaining cases involved sub-standard watchman service.

The reasons for this unsatisfactory experience are as follows: In 10 buildings (6 with standard watchman service) the fire broke out between rounds, in 5 cases watchmen were expected to perform additional duties (gate guard,



Wide World Photos

Despite the satisfactory operation of a watchman, this $1,250,000 Williamsport, Md., fire on Oct. 13th completely destroyed a 2¼-acre 1-story concrete block, wood-joisted building housing a silk mill and three other firms. These four firms employed at least 200 persons who lost their jobs.

The watchman in the boiler room heard an explosion. He investigated to find a fire in progress. Returning to the shop near the boiler room, he called the fire department. The responding fire department was caught with its new pumper out of service. Its old 1929 pumper responded and pumped for 12 to 14 hours without fail. Mutual aid companies sent additional help. It is unfortunate that the hydrant nearest this large unsprinklered plant could not yield more than 300 gpm at 20 pounds residual pressure. Only exposures could be protected by the few hose streams thus available.

Wide World Photos

A watchman was on duty daily in this ½-acre, 1- and 2-story brick, wood-joisted library in Bayonne, N.J. His job consisted mostly of janitorial work ending at 2:00 A.M.

After the watchman had left at 2:00 A.M. Sunday morning, May 31, the building and its 185,000 volumes were unattended and unprotected from fire. Sometime during the three hours before 5:00 A.M. a 24-year-old man jimmied a window and entered the building. He took periodicals and piled them on a table, then lit a corn broom and ran through the library stacks waving the burning broom from side to side. After three fires had been established, he was forced to jump from an upper window due to smoke and heat. He pulled the fire alarm box in front of the building at 5:06 A.M. and then ran off to hide.

Responding fire fighters found no one at the fire alarm box and saw no sign of fire, so assumed that this was just another false alarm. While it is true that false alarms dull the sharp edge of effective response, many fire departments require a building by building check of the area before returning to quarters. Since the advent of radio, this procedure has gained increased acceptance. In this case for instance a simple check of the alley beside the library would have disclosed the open window and the glow of burning pamphlets inside.

In any case the fire department was recalled by a neighbor at 5:16 A.M. and attacked the three fires in progress. Had the building been equipped with automatic sprinklers, the three fires would have been easily controlled and extinguished and water damage localized. As it was, the fire-weakened roof of the main building collapsed, the ceilings of the wings were damaged by smoke and heat, and the majority of books were soaked.

janitor, boiler operator, etc.); in 3 others the watchmen made irregular rounds; in two cases each: the fire started before rounds began (both standard); the watchman investigated and/or fought the fire before giving the alarm (both standard); patrolled an area too large for one man to cover, and left the building (1 a detective service agent who inspected many buildings, and another AWOL). In one instance each: the watchman patrolled outside the building only; he was asleep; the fire started in an area out of sight of his rounds; he stopped standard rounds because of a water leak; and finally, a watchman, on what were meant to be standard rounds, escaped the fire while the clock he carried was completely destroyed in the blaze.

Jan. 23, State College, Miss., Mississippi State College 1 killed; $1,030,000

COLLEGE DORMITORY. At 2:30 A.M. fire, burning above the third story ceiling, was discovered by one of the approximately 1100 students sleeping in the old, unsprinklered 3-story brick, wood-joisted dormitory. The rectangularly shaped building (ground floor area of over 1-acre) surrounded a large inside courtyard. As watchmen fired their revolvers in the courtyard, waking some occupants, students raced through corridors waking others. Flames broke through the ceiling into the third story where combustible interior finish, open hallways and stairs allowed fire to spread rapidly.

Confinement of the fire to the attic before discovery and the fact that the third story hallways were still passable when the fire was discovered explained how everyone happened to get out safely. The one death involved a boy who re-entered the building to recover personal belongings and was trapped. Fire fighting efforts by the students and by companies from neighboring towns (there was no local fire department) were futile due to the very poor water supply from private hydrants and the sprawling nature of the building, thought to be the largest dormitory in the world.

Fire walls at each corner of the building would have limited fire spread to one side of the building. Enclosed stairways added to fire wall construction might have made it possible for the fire department to limit the spread to the upper story and attic. On the other hand automatic sprinklers with a gravity tank would have limited the fire spread to one small section of the attic, and given the alarm promptly.

Automatic Detection Equipment

Automatic detection equipment was installed in 3 of the properties included in the 1959 large loss building fire record. Two of these were auxiliary systems connected to the fire department. The other was a proprietary system connected to a plant gate house. In only one of these 3 fires was detection delayed. Both auxiliary systems operated promptly to give the alarm, but the proprietary system signal was delayed as the fire burned in an unprotected concealed ceiling space. In addition to the fires first discovered by automatic fire detection systems, there were three cases where discovery was by automatic sprinklers.

Sept. 8, Los Angeles, Calif., U. S. Air Force Lookout Mountain Laboratory $493,500

MOTION PICTURE STUDIO. A 27,000 sq. ft. multi-level wooden building with dry wall construction was heavily damaged because of several errors of judgment. The building had been built over a long period of time and additions added to additions that had been added to annexes.

Error 1: Wiring did not conform to the National Electrical Code (NFPA No. 70).

Error 2: While most of the building was free of combustible acoustical tile one equipment room housing expensive electronic equipment was covered with a considerable amount in order to lower the noise level.

Error 3: Although the combustible building had recently been equipped with a wet pipe sprinkler system, this system was not installed in the equipment room due to fear of damage water might cause to the electronic equipment. An automatic detection system was placed in the room but not run into the concealed ceiling space over the room. Both sprinkler and detection systems sounded the alarm in the guards' office.

Error 4: The electrical circuits ordinarily were de-energized at the end of the day. Some occupants had noticed them getting warm due to the large loads the inadequate circuits were expected to carry. On this long Labor Day week end, however, someone had forgotten to shut them off.

The result of these errors was overheating in the concealed space over the electronic equipment room. This caused a fire. The fire burned undetected until it burst forth into the equipment room and set off the automatic detection system and a few sprinklers outside the equipment room. Thus, none of the expensive electronic equipment was wet but the fire destroyed it all. The partial sprinkler system operated effectively to limit fire spread to the room of origin.

1959 Large Loss Building Fires —

Alarm of Fire

The alarm of fire is the second step in the fire control operation. Just as detection should immediately follow ignition, so should the alarm instantly follow detection.

Of the 331 large loss building fires an immediate alarm was given for 238. There was no alarm in 5 cases. The alarm was delayed in the remaining 88 cases (26.6 per cent).

Alarm vs. Detection

There is some confusion between the terms "delayed detection" and "delayed alarm." Prompt detection of a fire does not necessarily mean that the alarm to the fire department will be sent promptly. A study of the 88 cases of delayed alarm revealed that in 62 cases there was an additional delay to an already delayed detection, but in 26 cases it was an *unnecessary* delay to an otherwise *prompt* detection. Thus in 270 (81.5 per cent) of the large loss fires in buildings there was either delayed detection, delayed alarm or both.

Alarm Means

The initial alarm of fire was made by telephone in 230 cases, by street-mounted fire alarm box in 40 cases, by radio in 18 cases (police — 14, taxicab — 2, fire — 1, and water department truck — 1), verbal alarm at the fire headquarters in 16 instances, by private fire alarm box in 4 cases, by automatic sprinkler equipment in 2 cases and by automatic fire alarm equipment directly connected to the fire department in 2 cases. The remaining 14 alarms were given by miscellaneous methods.

July 17, Vancouver, B. C., Wosks Ltd. $347,025

DEPARTMENT STORE. About 10:25 A.M. a water department employee working in the street discovered smoke coming from this 60-ft. by 120-ft. 4-story brick, wood-joisted building. He used his radio-equipped truck to give the alarm to the fire department. The fire originated in an appliance storage area and gutted about half of the fourth story of the unsprinklered building. The lack of windows in the upper story of the converted theater building severely handicapped ventilation and extinguishing efforts by the fire service.

August 4, Richmond, Ky., First Christian Church $338,000

CHURCH. This unsprinklered 3-story masonry, wood-joisted church building was to be painted. On Monday, Aug. 3, the painters moved in and covered everything in the $338,000 building with plastic drop cloths, including the balcony rail. At 8:15 P.M. that evening a 900-watt bulb attached to the balcony rail was turned on by a time switch. It was not until 4:00 A.M. that a passing motorist saw the fire and drove to the fire department to give the alarm. The long-delayed detection and the somewhat delayed alarm were the major factors in the building's destruction.

Alarm Delays

Occupants Fighting Fires

The most frequent reason for the 88 delayed alarms was the occupant who chose to fight the fire rather than give the alarm, thereby delaying the arrival of fire fighters. There were 36 such cases among the 1959 large building fires. One occupant was a watchman.

Delayed Telephone Alarms

Of the 88 delayed alarms 18 were due to difficulty with telephoning. In 6 of

Sun Photo

This $1,140,000 fire in a Baltimore, Md., grocery warehouse was one of 40 large loss building fires in 1959 that were reported to the fire department via a public fire alarm box. The prompt use of public fire alarm boxes following prompt discovery will usually mean an effective job of fire control. Where, on the other hand, the alarm transmission is delayed for any reason, the value of the fire alarm box as a factor in the outcome is apt to be reduced or eliminated.

This May 9 fire was started by a child playing with matches. By the time a passerby had discovered it and pulled a fire alarm box, it had made so much headway that first responding companies sounded alarms for additional companies. Besides delayed discovery other factors responsible for the near total loss were absence of automatic sprinklers, failure to extend a division wall through the metal roof (it extended to within 4 inches of the deck), and weak public water supplies.

these fires the alarm was delayed due to burned telephone wires, in 4 cases the discoverers called the wrong party, in 3 the telephone was inaccessible, in another 3 cases the bystanders failed to call the fire department, and in 2 there were no telephones available.

Other Delayed Alarms

Of the remaining 34 cases of delayed alarms occupants who investigated first (6), and local alarms not recognized by the public (2), were the principal reasons.

Dec. 20, Beaver Falls, Pa., Great Atlantic and Pacific Tea Co. $432,000

SUPERMARKET. One of the nine large loss supermarket fires of 1959 was set on a Sunday afternoon by a 10-year-old boy who ignited a stack of bread cartons on a rear loading platform after pouring lighter fluid on them. A woman who knew the boy and saw him set the fire did not give the alarm until the fire had spread out of control.

The causes of large loss supermarket fires differ, but their methods of spread usually follow a similar pattern. Heat from the loading platform fire ignited stock piled

James March, Jr.

against the inside of a metalclad door. Christmas stocks were piled to the ceiling in the unsprinklered stock room. Spreading through the stock to a flimsy combustible partition between the stock room and sales area, the fire spread up the partition and entered the undivided 4-foot-deep concealed space between the wood roof deck and the metal ceiling of the sales area. When sections of the roof collapsed, they knocked down the ceiling and allowed fire to enter the sales area.

Michael J. Kiley

The difficulty of fighting fire in concealed spaces is clearly illustrated by supermarket fires. During recent years 6 or more of these large unsprinklered stores have been completely destroyed annually.

A typical example in this Feb. 28 fire in Farmington, Mich. Investigators found a fan blade on a roof-mounted water cooling tower bent in such a way that the fan would not turn. It is thought that the current drawn by the jammed fan motor overheated the wires in the concealed attic space and started a fire in this space. The fire spread down into the service area at the rear and was spotted about 7 P.M. by the store manager as smoke spread into the unsprinklered store.

The life safety problem in such buildings is also illustrated by this case. The ⅓-acre 1-story concrete block, wood-joisted building was occupied by several patrons and employees. The store manager yelled "fire" and raced toward the service area with a carbon dioxide extinguisher. Everyone else in the store fled. As he discharged the extinguisher the lights went out and a mild explosion occurred. Smoke poured into the sales area. By crawling and groping his way toward the door he knew so well he was able to reach the check-out counter. He stood up and started to run. He hit a standing display which threw him to the ground and broke his glasses. As he groped for the door he hoped the electrically operated doors were not out of commission. Fortunately they were not and he reached safety with 1st degree burns on face and hands.

By the time the fire department had driven the two miles the fire was well out of control.

1959 Large Loss Building Fires —

Spread of Fire

The 1959 large loss analysis proves again what has already been shown in previous large loss studies, that large loss fires usually occur when fires spread over large areas. The principal means, therefore, for preventing large loss fires is the limitation of fire spread by the provision of fire walls, stairwell enclosures and other fire-limiting structural features, and by the provision of automatic fire extinguishing equipment. (See Private Fire Protection.) It is true, of course, that a few fires each year cause a large loss without leaving the room or area of origin. These fires, however, are the exception as shown by the fact that construction weaknesses were a factor in 280 (85 per cent) of the 331 large loss building fires.

The following material is divided into subsections that cover the extent of fire spread and construction features which influenced the spread of fire.

Extent of Fire Spread

Confined to Room of Origin

In 3 cases (0.9 per cent) the fire did not spread beyond the room or area of origin.

Confined to Floor of Origin

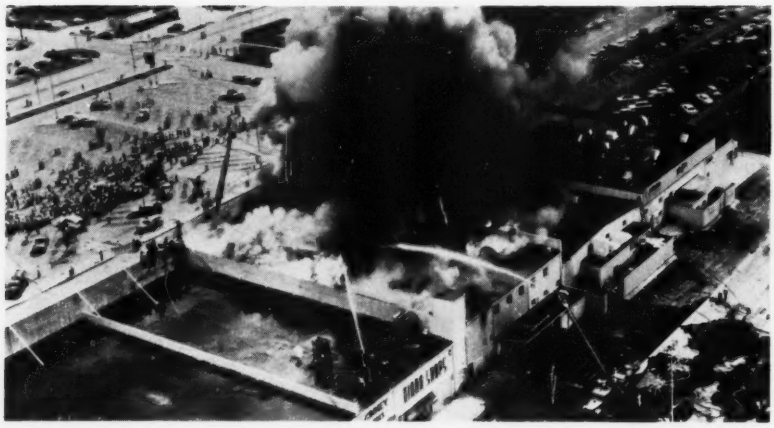
In 18 cases (5.4 per cent) the fire spread beyond the room of origin but was confined to the floor of origin.

United Press International

An illustration of the fact that a large loss fire can occur in a small area or room is a May 20 fatal $630,000 fire in an aircraft fuselage.

Seven employees of this Middle River, Md., aircraft repair station were using a corrosion inhibitor remover of two-thirds toluene and one-third denatured alcohol inside the fuselage of a Martin Flying Boat. To remove the flammable vapor hazard, air was being pumped into the 6,600 cubic foot fuselage at 7,500 cubic feet per minute, theoretically a complete change every 53 seconds.

The stripping operation was approaching its second hour when a low order explosion took place. Five of the seven men in the fuselage were killed by the explosion. The ensuing fire was confined to the fuselage by the operation of the hangar deluge system. Final extinguishment was accomplished in a few minutes by fire brigades using water foam.



Airflite

This fire was confined to the floor of origin by the fire walls separating individual stores and by good fire fighting techniques.

Fire walls have often been omitted by builders of shopping centers with the result that fires of 1- to 2-million-dollar size have been common. But for parapeted fire walls this $404,500 fire would undoubtedly have fallen in the million dollar category. Large loss fires in shopping centers will become a thing of the past when the economies of division walls and automatic sprinkler installations are understood.

This July 3 fire in a St. Petersburg, Fla., shopping center was believed caused by an overheated motor. It burned undetected until spotted by an employee of a window washing concern about 7:30 A.M. Smoke and water damage occurred in both neighboring stores with fire damage total in the area of origin.

Confined to Building of Origin

In 225 cases (68.0 per cent) the fire spread beyond the room of origin and beyond the floor of origin to destroy the entire building.

Spread Beyond Building of Origin

In 80 cases (24.2 per cent) the fire was able to spread beyond the building of origin and into other buildings.

Outside Fire Spread into Building

And finally in 5 cases (1.5 per cent) a fire that started outside of the building was able to spread into it.

***July 15, Lanark, Ont., Campbell Sash and Door Factory, et al. $738,500**

An example of a fire spreading outside the building of origin is this fire where wood shingle roofs, 40 to 50 mph winds, and an inadequate public water supply combined to destroy a large mid-town section of Lanark, Ont. Starting during the Monday lunch hour in a 60 ft. by 100 ft. 2-story wooden woodworking shop, the flames spread rapidly to the shop's other five buildings. Flaming brands carried downwind ignited other wood shingle roofs even before the local volunteer fire department could set up relay operations from the town river 2,500 feet away. As the fire swept through the business district the telephone exchange was destroyed. With the telephones out, the Provincial Police radio network had to be used to call mutual aid fire

Toronto-Star

*Fire spread to other buildings.

United Press International

A contractor's trash fire smoldered for two days in sawdust and wood chip-filled land in Tacoma, Wash. On July 19 it spread under the pilings of a building being razed and then into the building. From this building the fire spread to two sprinklered warehouses storing grain and building materials. In both buildings sprinkler water had been shut off. No explanation is given except that in the grain warehouse the sprinklers were shut off to prevent water damage to the grain that was completely destroyed in the $580,000 fire.

fighting forces. Many home and business owners desperately trying to wet down their combustible roofs were driven off them by the dense smoke and flaming brands. At least 25 were successful, however, in extinguishing fires on their roofs.

At one point the flames leaped the narrow river igniting a large knitting mill, economic reason for the town's existence and the employer of 200 of the townsfolk. Fortunately the fire was held to the boiler house. The town library and fire station were destroyed along with the town hall.

The box score was tallied; 34 of the 90 buildings in town destroyed, 16 of the 31 businesses leveled, and over 110 (40 families) of the town's nearly 1,000 residents made homeless.

Building Construction

All types of buildings were involved in the large losses of 1959. Seven fires (2.1 per cent) occurred in buildings of fire-resistive construction; 18 fires (5.4 per cent) occurred in noncombustible buildings; 7 fires (2.1 per cent) in noncombustible buildings that had combus-

Bill Wilson

An $871,500 fire occurred Feb. 3 in this Atlanta, Ga., noncombustible warehouse (brick walls, concrete floor, gypsum slab on unprotected steel roof) in which contents were predominately noncombustible (automobile parts). The fire had made great headway in the undivided, unsprinklered 38,000 sq. ft. structure when first seen at 1:48 A.M.

Originating in the vicinity of a gas-fired suspended unit heater, fuel for the fire included some wooden shelving, paper and cardboard cartons in which some of the stock was packed, and the grease coating on some of the stock.

tible roofs and 177 fires (53.5 per cent) burned in buildings of masonry, wood-joist construction. All-wooden buildings experienced 51 fires (15.4 per cent); wood-framed, metalclad, 21 fires (6.3 per cent); mixed construction, 39 fires (11.8 per cent); buildings of miscellaneous other construction and those for which construction details are not available accounted for the remainder.

Dec. 24, Horsham, Pa., Bargain City, U.S.A. $1,100,000

MULTIPLE OCCUPANCY MERCANTILE. The Bargain City, U.S.A., chain store built two undivided 750 ft. by 200 ft. prestressed concrete buildings in different locations. Five rows of reinforced concrete columns 50 ft. on centers ran the full length of each building. The two outside rows formed the building wall line. The columns within the rows were spaced on 30 ft. centers. Prestressed concrete beams 30 ft. long rested on top of the columns. These beams formed a base for the 50-ft.-long prestressed concrete roof members. These members were interlocking winged-channel units (see photo below).

It was planned that both these "twin" stores would be 100 per cent protected by automatic sprinkler systems. A contract had been let and work was slated to begin just after Christmas.

At 2:10 A.M. on Dec. 24, a fire, of as yet undetermined cause, was discovered in the narrow stock room and furnace area along the rear of the Horsham, Pa., store. Separated by a concrete block wall but not cut off from the retail area, the stock room contained heavy concentrations of combustibles (plastics, paints, tires, clothing, etc.). These gave the fire fuel for rapid spread and intense heat generation. Though the alarm was radioed by a security guard promptly after discovery, the fire department found on arrival that the fire had spread through the unprotected openings in the concrete block service area wall and had also heavily involved the sales area.

Fire department operations were hampered by the lack of nearby hydrants (nearest 3500 ft. away) and some windowless wall sections creating areas within the building inaccessible to hose streams.

Damage by the contents fire to the prestressed concrete building included roof collapse in several separated areas and severe

The Evening Bulletin, Philadelphia

The first large loss fire in a prestressed concrete building is reported above. In addition to this illustration of contents fire damage, the effect of combustible interior finish on fire resistive buildings is illustrated in the fatal Tuller Hotel fire in Detroit and the expensive Pentagon Building fire, both reported in this QUARTERLY, pages 366 to 368.

Thomas Morrisey

One of the 177 large loss fires to occur in a brick, wood-joisted building originated in the basement of Godfrey Building, Ottawa, Illinois on July 6. The fire originated in the basement and was still confined to this area when fire fighters answered a neighbor's alarm at 2:14 P.M. However, due to the absence of automatic sprinkler protection and lack of sidewalk access openings and basement windows, the fire could not be controlled and soon started to spread through the 2-story store and apartment building. Numerous partitions and division walls in the building were useless as fire barriers because of unprotected openings.

damage and spalling to the rest of the building. The structure was considered unsafe for future occupancy and is to be torn down.

Inadequate Fire Divisions

The principal structural factor in the *horizontal spread* of fire is the failure to provide adequate division walls. Absence of such a division wall (instances where good judgment would have recommended subdivision) was noted in 59.6 per cent (197) of the fires. Substandard construction of the wall itself was a factor in 7 cases (2.1 per cent).

In 45 cases (13.6 per cent) openings in the division wall were a factor in the *horizontal spread* of fire. In 18 cases window or door openings were unprotected while in 7 instances unprotected conveyor or belt openings allowed fire to spread through the barriers. Seven division walls were protected in a substandard manner, 5 with substandard doors, one with ordinary (not wired glass) windows, and in one case other openings were protected in a substandard manner. Six fire doors were blocked open or were otherwise inoperative thereby permitting fire to spread beyond the division walls in which they were installed.

Dec. 29, Cazenovia, N. Y., Cazenovia Junior College $300,000

WOMEN'S JUNIOR COLLEGE. Three adjoining sections of a large building built at various times since 1810 were destroyed when fire spread past a single fire door which may not have been closed and through continuous (nonfirestopped) timber and joist sockets in the brick division walls. The flames were kept from entering fire-resistive Hubbard Hall on one side by fire doors. Good fire fighting kept the fire from the section on the other side.

The fire was believed to have originated from electrical defects in the concealed ceiling space over the first floor lounge where it was first discovered. The time of origin (8:10 P.M.) and the Christmas vacation kept the college from repeating the 1947 fatal lounge fire that destroyed the section which was replaced by Hubbard

Zito Studios

Fire was beyond control in the Sunday school section of this unsprinklered 2-story concrete block, wood-joisted church in Ridgewood, N. J. when discovered by outsiders at 3:38 A.M. on Jan. 21. Flames were coming through the roof when firemen arrived. A 12-inch-thick concrete block wall separated the Sunday school from the church. Wooden doors in this wall at the first and second story levels and an unprotected opening in the basement allowed the fire to enter the church on all floors.

Gary Fire Department

The effectiveness of a properly mounted fire door in a fire wall is demonstrated in this case.

A 60 ft. by 90 ft. section of the 60 ft. by 650 ft. Indiana Wholesale Food Corp. warehouse in Gary, Ind., was destroyed by fire that was beyond control when discovered by cruising police at 5:47 A.M. on June 14.

The brick, wood-joisted building had no watchman or automatic fire protection. The building was, however, divided into three sections by masonry fire walls with automatic fire doors at openings. Automatic closure of the fire door in the fire wall between the section where the fire started and an adjoining larger section confined this $464,000 fire.

Hall. Though Hubbard Hall had been built of basically fire-resistive construction it had a combustible roof and the remaining combustible building sections were never sprinklered.

Horizontal Spaces Not Firestopped

The second major structural weakness affecting *horizontal fire spread* is nonfirestopped concealed spaces. Of the 45 fires (13.6 per cent) in which this construction weakness showed up, 42 (12.7 per cent) involved nonfirestopped ceilings where good judgment would have suggested safeguarding the open areas. The remaining 3 fires were in other nonfirestopped concealed spaces.

Mar. 21, Bayonne, N. J., Mademoiselle Shop, et al. $450,000

W. C. Zapp

SEVERAL DRY GOODS STORES. This fire burned for some time before it was discovered by an outsider at 3:32 A.M. The outsider pulled a public fire alarm box. The fire of unknown cause had entered the concealed nonfirestopped space over the suspended ceiling and spread easily through the several stores in the building. Buildings on all sides were damaged by fire, smoke or water.

Had the bricks used for the impressive false façade over the front of the stores been used to raise the between-store partitions to and above the roof level this fire could have been confined to one store. Had this block been sprinklered, this fire would have been confined to a small area within one store.

Vertical Openings Not Enclosed

The principal factor in the *vertical spread* of fire is the failure to enclose vertical openings or the failure to provide standard enclosures for these openings. In 156 cases (47.1 per cent) this was the reason for extended vertical spread of fire. Open stairways accounted for 89 of these 156 cases.

Open elevator shafts were a factor in 19 fires (5.7 per cent).

Other unprotected openings affecting vertical fire spread were 12 conveyor openings, and 7 other openings.

Substandard enclosure of stairways, elevators and other vertical openings accounted for 29 cases of fire spread (8.8 per cent of building fires).

June 17, Philadelphia, Pa., New Yorker Cheese Products Co. $1,612,000

HAM, CHEESE AND DOG FOOD STORAGE. Shortly after 9:00 A.M. employees in the second story saw smoke coming from the open elevator shaft. As one of them ran to give the alarm the others suddenly saw flames burst out on packing materials stored on the second floor. The fire spread rapidly forcing everyone to flee from the unsprinklered 4-story brick wood-joisted building.

Investigators determined that the fire started at the electric motor on a diffuser of the first story refrigeration system. Fire spread along the combustible ceiling tiles beneath which the diffuser was suspended and spread to upper stories by means of open stair and elevator shafts and openings around columns. (Fire coming up through an opening around a column accounted for the outbreak of fire in packing material stored on the second floor.)

Jan. 11, Des Moines, Iowa, Elks Club $295,000

CITY CLUB. Originating in the concealed space above the suspended ceiling of the basement dance hall, the fire burned through flooring to the first story and also entered hollow partitions. Open stairways and dumb waiter shafts were the routes traveled by flames to upper stories. Resistance heating of No. 14 wiring overfused with 30 ampere fuses was the apparent cause of fire in the unsprinklered 3-story building.

Kitchener-Waterloo Record

Fire walls in these Kitchener, Ont., mercantile buildings that should have protected adjoining buildings from fire were made ineffective by plain glass lights in windows and other unprotected openings in the walls. On Dec. 16 flames spread through these openings to involve a group of 1-, 2-, 3-, and 4-story brick, timber-, and steel-beamed buildings occupying a 136 ft. by 161 ft. area. At least 41 stores and offices were involved (loss: $970,000).

Vertical Spaces Not Firestopped

The second largest factor in the *vertical spread* of fire is the nonfirestopped concealed spaces. Of the 47 vertical concealed spaces involved in this year's large losses 45 were within walls.

Combustible Interior Finish

In 58 fires (17.5 per cent) the combustibility of the interior finish was a factor in the outcome. In 37 of these fires combustible fiberboard, either acoustical tile or sheets, was the interior finish influencing fire spread.

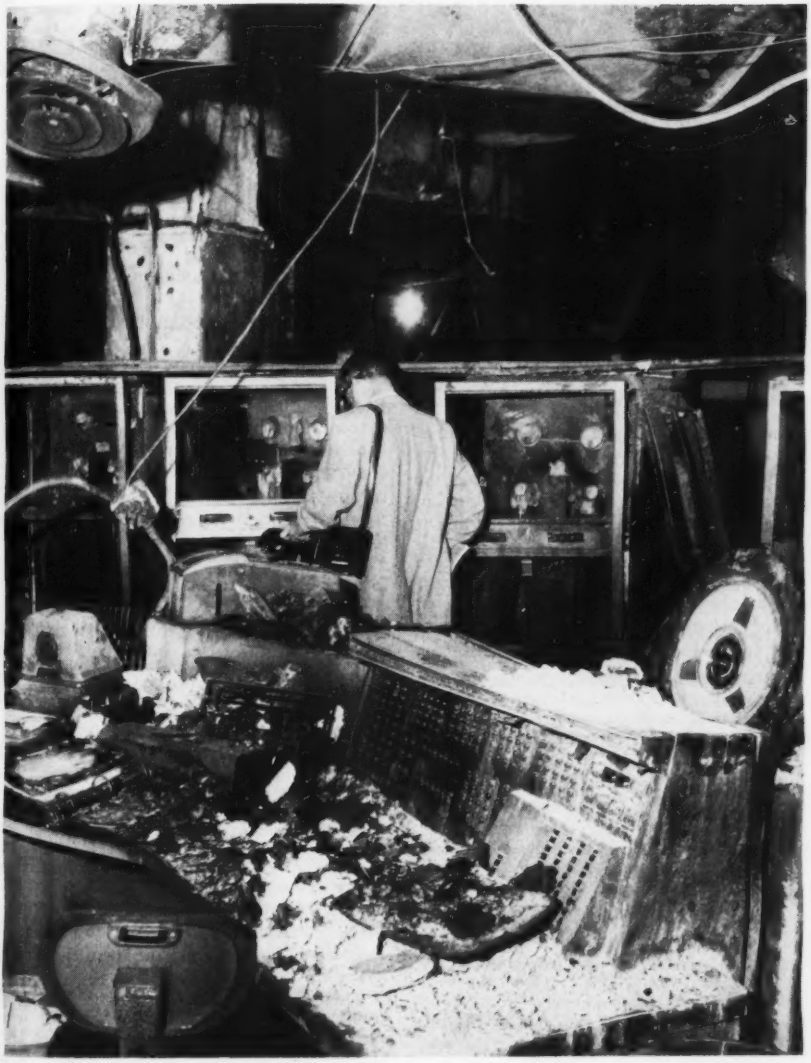
The remaining 21 interior finish fires involved other types of finish from pressed hardboard to plywood.

The fire had burned for 20 to 30 minutes in the basement of an occupied supermarket before it was found by an occupant and the alarm given at 4:19 P.M. Poor entrance facilities to the basement of this building hampered initial fire fighting efforts. Meanwhile the fire raced up nonfirestopped partitions and took hold in the open concealed spaces between ceilings and floors. Fire spread also up an elevator shaft and open stairways.

Jan. 17, Detroit, Michigan. Tuller Hotel. 4 killed $500,000

HOTEL. Three hotel employees and an 82-year-old guest lost their lives when fire heavily damaged the lobby and second story of the unsprinklered 800-room, 14-

Press Picture Service



United Press

The Pentagon Building, Arlington, Va., where a $6,690,000 fire occurred on July 2, was properly classified as a fire-resistive building because of its reinforced concrete construction. However, the combustible partitions which honeycombed the building, concealed spaces containing wood framing and other combustible materials, and suspended combustible ceilings (not to mention the inevitable combustible contents associated with office buildings) provided ample fuel for this disastrous fire. The detailed report of this fire, which was published in the August 1959 NFPA *Fire News* (reprints available) calls attention to the extreme fire fighting difficulties associated with fires in the interiors of large unsprinklered buildings.

story fire-resistive hotel. Careless disposal of a lighted match into a cardboard box of papers in a hat shop off the lobby was the cause. When seen by hotel employees who could look through a glass partition into the hat shop the fire was confined to the box of papers.

The fire department was not immediately called. Instead, two employees grabbed extinguishers from the lobby and entered the shop from the street entrance but were confronted with a fire too large to be controlled with extinguishers. At the same time that the two hotel employees went to fight the fire in the shop, an assistant manager took an elevator from the lobby to the basement where he assembled some extinguishers and two other employees and returned via the elevator to the lobby. Heat had by then broken the glass in the door between the shop and lobby and flames had spread rapidly over the lacquered plywood wall finish and the combustible acoustical tile ceiling finish in the lobby. When the elevator door was opened at the lobby level the three men were met by heat, smoke and flames. They were able to close the elevator door, but when later found, the three employees were dead of asphyxiation in the elevator which was still at the lobby level.

It is believed that the fire department was called after the fire burst into the lobby. On arrival of the first company (1½ minutes running time) guests were hanging from several windows of lower stories, the building was rapidly filling with smoke, and fire, smoke and heat were spreading up an open stairway to second story corridors. Many guests were taken down ladders, others used rear enclosed interior stairways that discharged to the street.

Thirteen guests were injured by smoke inhalation and an 82-year-old guest died of pneumonia contracted as a result of the fire.

Nov. 10, Southfield, Mich., Plum Hollow Golf Club $375,000

COUNTRY CLUB. In most large fires several factors contribute to the extent of damage. One of the factors that played an important part in this clubhouse fire was the combustibility of the interior decorations and finish.

A small male card party had broken up in the club grill about 7:30 P.M. The ash trays were thought to have been dumped into a wastebasket. A small fire developed and involved a curtain. The curtain ignited the varnished wood wall finish and the combustible fiberboard ceiling finish. A watchman smelled smoke just before he started his 8 P.M. round through this unsprinklered 20,000 sq. ft., 1-story wooden country clubhouse. Investigating, he found flames rapidly spreading over the combustible fiberboard and varnished wood interior finish. He ran to the telephone switchboard but was driven away by black smoke and fire before he could place the call. He then ran out of the sprawling clubhouse and 1,000 ft. to the club manager's home where the alarm was telephoned at 8:09 P.M.

By the time the fire department could arrive, flames were involving most of the building. The lack of adequate manpower prevented maximum use of fire fighting equipment and replacement of the overcome fire fighters. Aside from the handicap records rescued from the pro shop by a masked fire fighter, *all* club records were destroyed including membership and dues records.

Combination of Deficiencies

The action of a typical fire, spreading both horizontally and vertically, is well illustrated in the following case.

Feb. 26, Oakville, Ont., Trafalgar Building $619,500

FURNITURE STORES, OFFICES, AND NEWSPAPER PLANT. After his 85 ft. by 100 ft. 4-story building had been gutted by an evening fire, the owner lashed out at the lack of an adequate fire fighting force as the basic cause. Any experienced fire protection engineer would disagree. The building, the newest in town, was assigned its fate on the drafting table and regardless of what city it had been located in, the results would probably have been the same.

The design defects included the following items: combustible interior finish in the form of combustible fiberboard ceilings; plywood office wall coverings; lack of horizontal cutoffs especially at the 5¾ ft. separation between the two building wings which on the third and fourth floors had plain glass lights in wooden frames directly opposite each other; lack of vertical cutoffs in the form of open stairwells; concealed ceiling spaces; combustible construction (brick, wood-joist); and, of course, the lack of any automatic fire protection equipment.

Building Equipment

Building equipment hazards often have a great effect on the spread of fire as shown in the following illustrations.

Hazardous Area Not Cut Off

There are certain areas or operations in most buildings that present an extra hazard. Prudence indicates that these areas should be cut off from the rest of the building. In 8 cases boiler rooms or other hazardous areas were not thus cut off.

Feb. 4, Richmond, Va., Richmond Foundry and Mfg. Co. $375,000

MANUFACTURE OF PLUMBING SUPPLIES. Lack of automatic sprinkler protection for a paint drying room and failure to cut off this room from the adjoining machine shop were principal factors responsible for the large loss.

The breaking of an infra-red drying lamp ignited paint residue or vapors. The flames swept through the drying tunnel. An employee soon spotted the flames and ran outdoors to the control valve for a manually operated fixed carbon dioxide extinguishing system installed in the tunnel. On doing so he left the outside door to the drying room open. With the inside door between the drying room and the machine shop also open, a strong breeze swept the flames out of the drying tunnel to the room and from the room into the shop.

By the time the carbon dioxide was discharged, flames were well established outside the drying tunnel. Heat from the fire in the unsprinklered drying room opened so many sprinklers in the machine shop that the water supply was overpowered and the shop, patterns, machines and tools were destroyed.

Fortunately, properly constructed fire walls had been provided to separate the hazard of the machine shop from the rest of the plant. These walls limited the fire to the machine shop and paint baking area. Why fire wall and fire door protection had not been provided to separate the hazardous unsprinklered paint baking operation from the machine shop was not explained in the reports.

Unprotected Ducts

Duct systems spread fire and smoke in 8 fires.

March 13, California, Pa., Phillipsburg School $420,000

Observer, Washington, Pa.

GRADE SCHOOL. Shortly after 9 A.M., when the 300 children were in their classrooms, a teacher smelled smoke and notified the janitor. The latter discovered fire at a ceiling fixture in the second story and noticed that the ceiling fixture was red hot. When the fire exit drill alarm was rung, the building was evacuated in less than a minute. While the alarm was being telephoned by a teacher, the janitor returned to the fire area and found over one-half of the combustible ceiling now on fire. He discharged three 2½ gallon soda-acid extinguishers, but these had no effect on flames spreading within the three-foot concealed ceiling spaces.

The fire spread quickly throughout this building on entering hot air ducts. Ducts were not equipped with smoke detection equipment to shut down fans. These operated for twenty minutes after the alarm until electrical power was cut off.

Investigators found that insulation on wiring had deteriorated and in some places bare wire was visible. Thirty ampere fuses had been placed in circuits that should have been protected by 15 ampere fuses.

Building Contents

If a building is fire-resistive in construction and finished with noncombustible materials, then the only remaining fuel for fire is the contents of the structure. In 169 fires (51.1 per cent) one or more of the contents features of the building were a factor in the outcome.

London Free Press

With power lawn mowers stored in one wing, piled almost to the ceiling and obstructing the windows, it was impossible to use the windows for access and ventilation of the unsprinklered ⅓-acre, U-shaped, masonry, wood-joisted London, Ont., warehouse. Combine this fact with a delayed Sunday morning discovery (Feb. 22) of at least one hour and another large loss fire is explained.

Metal stored in cardboard cartons gives many uninformed persons a feeling that there is little to burn. The photo above is a remarkable shot into a fire in the 50 ft. by 105 ft. wing of the storage building. This wing contained 7000 new metal rotary lawn mowers stacked in cardboard cartons. Ignoring the minor fire in wood and in empty cartons at the lower left of the doorway, look at the 10-ft.-deep cloud across the top half of the doorway of burning gases seething inside. How could so much hot gas accumulate with so "little to burn"? Seven thousand metal rotary lawn mowers mean 7000 cardboard cartons, 7000 insulated ignition wires, 14,000 rubber or plastic handle grips and 28,000 rubber tires.

Tom Merryman

The grill vent duct passed up through the dining room ceiling and through the roof of this new Cedar Rapids, Iowa, motel restaurant. The vent contacted the wood ceiling and roof joists in the concealed attic space.

When the kitchen help were preparing for a capacity evening crowd on July 13, a ½-gallon pot of melted butter spilled on the hot charcoal grill. Employees raced for extinguishers but picked the Class A pressurized water type instead of the Class B, C dry chemical type hanging nearby. The unsuccessful attempts to extinguish the fire continued for about 25 minutes before the fire department was called. By this time the hot vent had ignited the concealed joist and the $261,000 fire was on its way.

The $450,000 motel units were not connected to the restaurant-bar building and were thus saved.

Improper Storage Practices

The largest contents factor was improper storage. Of the 91 cases where storage methods contributed to the extent of damage, 32 were due to poor stock subdivision, 30 to stock that was piled too high, and 9 to inadequate clearance between stock and windows or walls. Twenty cases involved other storage factors.

Flammable Liquids

Second on the list of complicating contents factors were the 84 flammable liquids fires. In 35 of these the liquids escaped from tanks and drums, in 21 cases a flammable liquid container exploded. In 9 cases the liquids involved were in process equipment, in 6 others the flammable liquid escaped from fuel tanks of vehicles or planes, and in 3 cases piping failed or ruptured. The remaining cases were the result of miscellaneous reasons.

April 23, Kansas City, Kans., Thompson-Hayward Chemical Co. 3 killed, $653,000

WEED KILLER MANUFACTURE. An explosion in a high-pressure, steam-heated kettle in which 2-4-D was being prepared was responsible for the death of three men and severe injuries to five others, as well as the destruction of the manufacturing section of this weed killer plant. An uncontrolled chemical reaction is a possible explanation, but the exact cause of the explosion is not known. Eyewitness accounts indicate that the victims may have known something was wrong as they were seen running in the area of the exploded tank moments before the blast.

The explosion destroyed the manufacturing building, the adjacent bottling section and most of the connected storage building. Some of the 32 adjoining outdoor aboveground storage tanks containing about 140,000 gallons of alcohol and kerosene were also involved. A fire door in the fire wall to a one-month-old 85 ft. by 240 ft. warehouse held the ensuing fire until fire department hose streams could be brought into action.

In addition to the large amount of fire and explosion loss there was a $100,000 insured business interruption loss.

Gases

Third on the contents factor list were the 30 fires where gases were a factor. Nine fires involved natural or manufactured gas, 5 involved liquefied petroleum gas, 5 acetylene, 4 ammonia and 7 involved other combustible gases.

Gas container explosions occurred in 11 cases; gas escaped from piping in 10 cases and from cylinders and storage tanks in 3. In the remaining 6 cases gases were a factor for miscellaneous reasons.

Sept. 12, Port Sulphur, La., Plaquemines Parish Hospital $700,500

20-BOOM HOSPITAL. Final arrangements were being made in this T-shaped new 1-story fire-resistive hospital building for its opening only 10 days away. At just after 8:10 A.M. three people were in the building: a doctor sleeping in the doctor's lounge in one wing, a porter leaving the end of the other wing, and a contractor in the crawl space under the opposite wing checking for water leaks in the water piping.

At 8:15 A.M. an explosion, centering around the contractor in the crawl space, occurred. It is thought that the explosion was caused by an accumulation of either natural or marsh gas.

The force of the blast blew the door the porter had just closed off its hinges and sent him sprawling. The doctor escaped with little more than a rude, sudden awakening. The contractor in the crawl space was burned and "shaken" but he escaped with his life.

The building was heavily damaged. Investigation after the fire revealed that the contractor had not tested the gas piping. In fact tests after the explosion revealed several leaks in the remaining 20 per cent of the undamaged gas piping.

Dust Conditions

In 23 cases dusty conditions produced by the nature of the contents seriously contributed to fire spread. In 21 of these cases dust was on structural members, and in 2 dust explosions occurred.

Poor Housekeeping

In 18 cases poor housekeeping was a factor in the fire spread. In 7 cases oily or greasy deposits were a problem, in 3 cases the accumulation of rubbish was a factor, and the remaining 8 were due to various causes.

April 10, Willimantic, Conn., American Thread Co. $253,000

COTTON MILL. Oily lint deposits allowed to accumulate on the ceiling of this building played a large part in the extent of fire spread. Proper fire department use of sprinklers meant, in this case, letting the 62 sprinklers operate at close to 100 pounds water pressure for almost 3 hours while fire fighters rounded up smoke masks, located the fire, and extinguished it. Even with the $125,000 use and occupancy loss due to drenched machines and stock, the loss is minor in consideration to the value of the 5-acre 2-story brick, wood-joisted mill. Production revived quickly from 50 per cent operation after the fire to full production at the end of nine weeks.

This interesting case began at the first floor ceiling of the card room when lint accumulations were ignited by a hot light bulb or a spark from an empty fuse socket. An employee spotted the ceiling fire and immediately called for help. The alarm to the fire department was telephoned immediately at 4:24 P.M. The oily lint-covered ceiling and oil drip pots and pans for the long belt shaft generated heavy black smoke as they burned. The smoke drove employees trying to use dry chemical extinguishers from the building. Flames spread up through belt holes to the second floor. Fifty-five sprinklers were operating on the first floor and seven on the second floor. These 62 sprinklers were holding the fire.

The fire department arrived to find the building roof monitor difficult to open and

Lexington Herald-Leader Photo

It is often difficult to visualize from a fire picture the type and size of the building involved. Study the picture above for a minute and try to visualize the building before it burned. Then look below and see the same view in a Lexington, Ky., Fire Prevention Bureau photograph snapped several months before the fire.

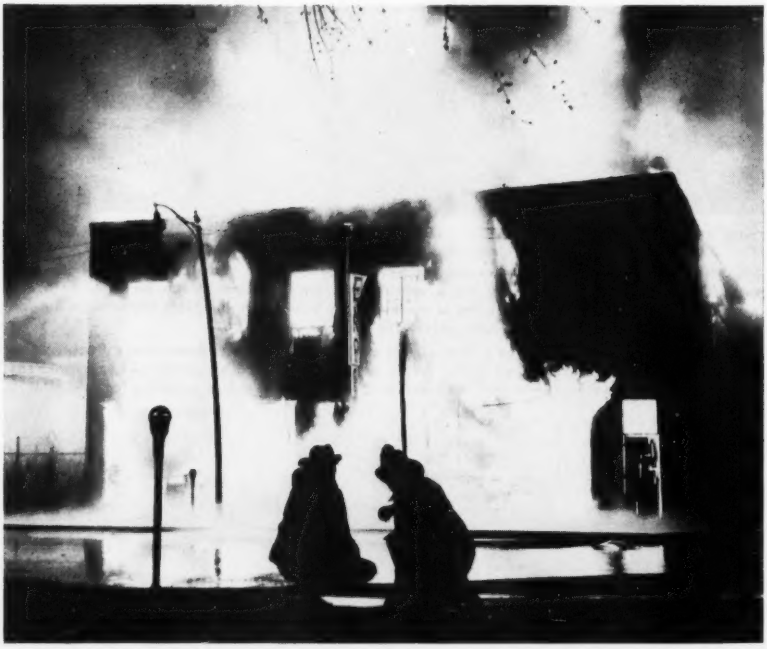
At 1:08 A.M. on July 10, a police officer cruising through the area saw a "small" fire inside the ¾-acre metalclad feed mill. As he picked up his radio microphone to report the fire it flashed over dust on structural members and involved the entire building for a $250,000 loss.

the second story windows glass block. With ventilation thus impeded, the call went out for all available smoke masks. Ten surrounding cities responded with this equipment. In the meantime men were stationed at the plant fire pump to start it if the pressure dropped too much, and twelve 1½-inch lines were laid from six 2½-inch lines from yard hydrants. As the masks arrived fire fighters penetrated the smoke to locate the fires and used the 1½-inch hose lines where needed to complete extinguishment. These fires were located under carding machines and in other areas shielded from direct sprinkler extinguishment. After all the fires were completely extinguished and the area checked, then and only then was the sprinkler system shut off. Due to the high water pressure, the intermittent use of hose streams, and the lack of drafting in private water mains, the plant fire pump was never needed.

There were 15 cases of other contents factors that were an influence on either fire spread or on fire fighting, such as the storage of explosives or ammunition.

Exposure Fires

No study of fire spread would be complete without a mention of exposure fires. In 85 fires the exposure problem was a big factor in fire spread. Eighty fires spread from the building of origin



Las Line

A building wall with a 1½ ft. parapet failed to keep this April 26 fire from extending over the wall and igniting the roof of a next door paper company, thus causing a complete loss of contents (about $85,000) of the exposed building and resulting in a $813,500 loss.

Standard building code practice is to require a 2 ft. parapet on exterior walls rated for 2 hours fire resistance and a 3 ft. parapet on walls rated for 3 hours or more.

Since there was no automatic sprinkler system in this Midland, Mich., Sears, Roebuck store, the fire burned unhindered until a low order explosion about 2:40 A.M. awoke an undertaker sleeping in the next door funeral parlor. By the time the alarm was telephoned and the fire department had set up its equipment, the fire had complete control of the building and the department's efforts had to be used to protect exposures.

to one or more other buildings, while 5 outside fires spread into buildings. In these fires one or more of the following items was a factor in the fire spread (listed in order of importance): inadequate separation between buildings (20), poorly constructed party walls (16), inferior combustible construction (15), interconnecting passageways, conveyors (12), explosion (7), ordinary glass windows (6), wood shingle roofs (4), yard storage between buildings (3).

***April 17, Pittsburgh, Pa., The Paper Craft Corp. $700,000**

PAPER WAREHOUSE AND PAPER WORKING. Exposure 1 — Boys smoking near the exterior tar-paper-covered wall of a 2-story wooden building which nestled in the corner of an ell-shaped 6- and 7-story fire-resistive building are thought to have caused a fire which destroyed the wooden building. The fire involved most of the exterior wall before it broke into the building and was seen by an employee. Further delay in fire department notification resulted when employees fought the fire with extinguishers. By the time the alarm was given heat sweeping into the wooden building had opened all 300 sprinklers, about 200 more than the water system was able to supply simultaneously.

Exposure 2 — As the wooden building burned, heat and flame exposed the large fire-resistive building through wired glass and metal frame windows that would not close completely and through substandard cutoffs. More than 125 sprinklers opened in the large building in addition to the 300 sprinklers already open in the wooden building.

The fire department connected two pumpers to the fire department sprinkler connection to the fire-resistive building after the wooden building collapsed breaking a 6-inch cross main. This reinforced water supplied sprinklers open in the exposed fire-resistive building to prevent fire spread into it.

*Fire spread to other buildings.

Galen Marford

One-third of the men and one-half of the pumpers had to be diverted from the 17-man, 4-pumper force at the $293,000 4-story flour mill fire in Newton, Kansas, on Mar. 17 to fight three wood shingle roof fires such as the one pictured above. The roofs were located 600 to 900 feet downwind and had been ignited by flying brands from the fire. One of the pumpers taken for this task was not connected to the hydrant system and was thus available, but the other one had to be disconnected and the three hoses it fed abandoned until it could be replaced by a mutual-aid engine. Ordinarily, citizens might have handled these roof fires with garden hoses, but the water pressure was so reduced by the major fire fighting operation that even the small hoses were ineffective.

Merrill Jones

This large Albany, Ore., plywood mill was partially shut down due to boiler repairs. The sanding section was operating, however, and the dust was being burned in the yard burner. The Aug. 6 wind with gusts up to 28 mph carried some of the sparks that escaped through the burner screen into the unoccupied open end of the mill. The 25 per cent humidity and 90 degree temperature made the thin plywood sheets and other combustibles stored there easy to ignite. The fire alarm was given at 4:44 P.M.

The plant was equipped with a partial sprinkler system, but unfortunately the fire started outside the small sprinklered area which was remote from the point of origin. By the time the flames reached the sprinklered area the heat had already opened many sprinklers reducing water pressure on the system and limiting effective discharge of the sprinklers. The water pressure was further reduced by the use of hose streams and the sprinklers were unable to hold the fire. As sprinkler and other plant piping broke, the water pressure was reduced even further. As there was no valve to shut off the water to this plant, the fire department had to rely heavily on water drafted from the millpond.

Flaming brands picked up by the wind traveled downwind setting fire to nine house roofs, half with wood shingles and half with composition roofs. Dried grass fields and fences were also ignited. Flakes of burned wood as large as 4 inches across were reported seven miles downwind. Mutual aid companies were needed to check fires downwind and to help with the main body of the fire. Aluminum from the siding of a renovated section of the plant was found, after the fire, stuck to the sides of dwellings 100 to 150 ft. downwind. These globs of aluminum had flown through the air in their melted state and ended up as ½- to 1-inch spots on the sides of the buildings.

Two hundred workers lost their jobs in the $1,423,000 blaze. In addition to the large property damage loss there was an additional $173,000 insured business interruption loss.

1959 Large Loss Building Fires —

Private Fire Protection

Most large loss fires become large because of the *absence* of private fire protection in high valued property; a few, because of the misuse, poor design, improper installation or inadequate maintenance of one or more of the various types of private fire protection. Typical examples of these latter cases from the 1959 large loss fire experience will be cited in this article.

Automatic Sprinklers

In 283 of the 1959 large loss building fires, the lack of automatic sprinkler protection was a definite factor.

In 1959, 35 automatic sprinkler systems were involved in large loss building fires. This is one less than the 36 involved in 1957 and in 1958. Fifteen of the fires occurred in buildings protected by complete systems, while 20 occurred in buildings with partial systems.

Any review of unsatisfactory sprinkler performance should mention the 1955 study of 58,971 sprinklered fires* which indicates that sprinklers perform satisfactorily 96.2 per cent of the time. The review here of sprinkler performance in the 1959 large loss fires will show graphically what happens when a sprinkler system is not designed for the hazard protected, is not backed up by a strong water supply, or is not maintained in operating condition.

Typical Unsprinklered Fire

Dec. 4, Springfield, Tenn., Bransford High School $279,000

High School. A faculty member walking outside during an evening basketball game noticed fire on the first floor of another wing of this 29,780 sq. ft. 2-story mostly brick, wood-joisted high school. Though this discovery had been delayed a possible 30 minutes, the building fire alarm was rung immediately, and the children calmly formed lines and marched from the gymnasium. Simultaneously the alarm was telephoned to the public fire department.

Fanned by brisk winds the fire spread along corridors and concealed spaces, despite the efforts of four town fire departments, until it was finally stopped by a masonry fire wall. The fire wall held the fire and aided in saving over 25 per cent of the 1949 portion of the building. Many books and the burned section of the building itself were sacrificed to the lack of sprinklers in this school building.

Completely Sprinklered Buildings

Of the 15 large loss fires in buildings equipped with complete automatic sprinkler systems, 3 systems performed satisfactorily and 12 systems did not operate satisfactorily.

The 12 unsatisfactory operations occurred for the following reasons. Closed valves were responsible for the unsatisfactory performances in 6 cases: in two of the destroyed properties, the sprinkler valves were closed prematurely (before the fire was extinguished), one valve had been closed for repairs to the system, another valve was closed for fear of water damage, and two were closed for undetermined reasons.

Three of the 12 unsatisfactory performances of sprinkler systems were because the systems were not properly supplied with water. In 1 of these three cases the fire pump was frozen, in another the fire pump was not started and in one there was insufficient water for sprinklers and hose streams.

*NFPA Quarterly Reprint Q48-12 (25 cents).

St. Louis Post-Dispatch

Sprinklers systems must be designed to protect the hazard the building presents. When they are not, the result is apt to be the same as if the building were not sprinklered at all.

On Feb. 3, in St. Louis, Mo., about 4:40 p.m., a fire broke out in a stack of cartons containing freshly made slabs of foamed polyurethane. Inadequate cooling of the oven-cured slabs before packing may have caused spontaneous heating. In any event the fire spread rapidly to a large adjacent storage pile and then quickly throughout the 1-story, concrete block, metal roofed plastic working plant.

The dry pipe sprinkler system was installed in 1956 on an ordinary hazard schedule and each of the 253 sprinklers was expected to cover 122 sq. ft. of floor area. The system volume was about 680 gallons. The water supply was capable of supplying 70 sprinklers.

Because the fire spread ahead of opening sprinklers, because the dry pipe valve did not have a quick opening device (as required by NFPA No. 13 for systems over 500 gallons in volume), and because it was a dry system, the building was destroyed.

The remaining 3 failures were due in two cases to an exposing fire which overpowered the sprinkler system in the exposed building and in the final case to a hazard too severe for the sprinkler system as designed.

Feb. 18, Latrobe, Pa., Alco Products Co., Inc. $900,000

RAILROAD SPRINGS, AXLES AND HEAVY FORGING. To economize, this plant removed a guard and closed one of its gates. This forced trucks picking up and discharging equipment at one of the buildings to use a narrow road that wound tightly around between the railroad siding and the buildings. On a Wednesday morning one of these trucks hit a post indicator valve for the sprinkler system in the 60 ft. by 250 ft. brick, wood-joisted wire spring shop and metallurgical laboratory building. The company management, which did not have a trained fire brigade to fall back on, did not notify the local fire department, did not place a fire watch in the building and did not supply the sprinklers through hose lines to the drain connection. The company personnel did, however, start immediate repairs and worked until about 10:30 P.M. when they quit for the night.

A heating unit in the wire spring shop had been giving trouble for some time before the valve damage Wednesday morning. About 11:00 P.M. Wednesday evening, employees in a nearby building saw flames between the wire spring shop and the metallurgical laboratory sections of the building. The employees placed a 2½-inch hose line from a nearby hose house in operation and someone turned on the broken valve in the now excavated pit. The valve was not yet in full

operating condition, as the pit quickly filled with water which gushed out at a high rate of flow.

The fire department was finally notified but found the building so heavily involved that little could be done other than protect exposures. In addition to the heavy dollar loss 16 men were removed from the company payrolls. It is interesting to note that those "out on the street" were in many cases men in other sections of the plant who were "bumped" by older men who had worked in the burned out building.

***May 9, Tacoma, Wash., Bartron Co., et al. $356,000**

TENANT WOODWORKING AND STORAGE. A building owner found that an old corroded sprinkler system had leaked and ruined 15 school desks in storage. Fearful of another leakage after the repairs, he placed air in the shut-off systems on Friday to see if the pipes were tight. If the air pressure held until Monday he would be satisfied and restore the systems to operation. On Saturday, however, a fire occurred and all 700 school desks were burned to ashes as was most of the ¾-acre building. Destroyed along with the desks were the various other tenants' belongings. Two other large unsprinklered buildings were exposed and destroyed.

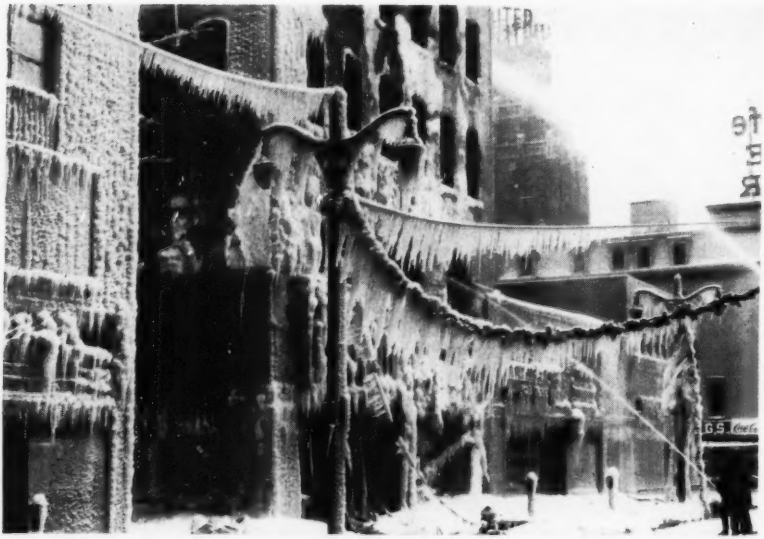
The fire started in an unlisted oil heating unit in an area occupied by a firm making formica countertops. Two workmen were in the building when they suddenly saw smoke coming from the heating unit. They yelled for the foreman while vainly searching for a fire extinguisher. The foreman finally was able to borrow an extinguisher from another tenant but by that time was unable to approach the fire close enough to use it effectively. A 40 mph wind spread the flames rapidly through the area with sprinklers shut off and to the exposed unsprinklered buildings.

*Fire spread to other buildings

Drennan Photo Service

The Sept. 27th annual dinner of Suffolk County Fire Commissioners Association had ended two hours before neighbors discovered fire in this sprinklered 158-room, 50 ft. by 475 ft., 5-story all wooden summer hotel. The dinner was held in the Sayville Plaza hotel casino, and the fire was first noticed in the casino kitchen. Though the Sayville, N.Y., hotel had been closed to overnight guests for several weeks, there were eight employees sleeping on the first floor of the hotel. These people were removed by responding fire fighters and did not suffer serious injuries.

The flames spread quickly through the open hotel corridors. The sprinkler alarm did not start ringing until the flames had entered the hotel proper. By that time the fire department connection to the sprinkler system was so exposed by the fire that it was inaccessible to the fire department. After the fire the sprinkler valve for the dry system in the casino portion of the building was found closed. The fire built up momentum in the area where the sprinklers were shut off and by the time it reached the sprinklered area it opened so many sprinklers that the water supply, already reduced by the hose streams, was inadequate to provide for control of the $450,000 fire.



Niagara Falls Gazette

An illustration of a partial sprinkler system that was not a factor in a fire is this Jan. 5, blaze in the Gluck building in Niagara Falls, N.Y. The $813,000 fire started in a concealed ceiling space above a first-story dry goods store and burned up through open stairwells to the roof. Defective wiring was the cause. At no time was the basement sprinkler system involved.

Fires in Partially Sprinklered Buildings

Of the 20 partial sprinkler systems in buildings involved in the 1959 large loss fires, 6 systems were not a factor in the outcome as they were not in the fire area.

Six partial sprinkler systems operated satisfactorily in that they kept fire from spreading from the nonsprinklered to the sprinklered areas.

In 8 cases partial sprinkler systems were ineffective. In 4 of these, fire started outside but spread into the sprinklered area; in one case, the valve was closed for an undetermined reason; in another the pipes were frozen; in one there was insufficient water for sprinklers and hose streams, and in the last the fire started in a sprinklered area and flashed to an unsprinklered area before sprinklers opened; it then spread back into the sprinklered section.

Feb. 17, Wichita, Kans., Boeing Airplane Co. $880,000

ENGINEERING OFFICES. When a partial sprinkler system operates because of a fire that originates in an unsprinklered area it is usually forced to discharge much more water than a complete sprinkler system as the water discharged is not effective in cooling the seat of the fire.

This 14,000 sq. ft. 4-story and part basement, mainly brick, wood-joisted building was sprinklered fully except for a cockloft between the fourth story ceiling and the underside of the roof. A fire was thought to have started in this roof space or on the roof above.

At 2:15 A.M. a motorist noticed a red glow at the roof of the building. He drove around the building in order to be sure the glow did not come from a neon sign. Sure now that it was a fire he found a taxi dispatcher station and reported the fire to the dispatcher. In order to back up this alarm

he drove 15 blocks to a fire station to notify the man on watch who initiated the alarm. No alarm was ever received from the taxi dispatcher.

This procedure for giving the alarm added about 15 minutes to the estimated 20 minutes burn before discovery. Thus there was a 35 minute delay before the fire alarm.

Thirty sprinklers on the fourth floor were operating and effectively holding the fire to the roof and cockloft, on fire department arrival. Heavy hose lines were set up and operated. A careful watch was maintained on the sprinkler system pressure and with orders to pump into the fire department sprinkler connection if the pressure dropped appreciably.

The roof collapsed in part and broke several small sprinkler lines, but the fire was held to the cockloft area.

Water from the partial sprinkler system and from the hose streams filled the fourth floor to a depth of 12 inches. Regular files kept the water off most papers, but lower drawers were flooded. Some engineering drawings were dried and returned to use, but others will have to be completely redrawn at a cost of close to $100,000.

Had there not been a partial sprinkler system there would have been an irrecoverable loss of burned drawings. Had there been a complete automatic sprinkler system, however, the fire would have been localized and extinguished with much greater speed and lack of damage even if the fire did originate on the roof, since then there could have been no fire extension into the concealed and difficult to extinguish cockloft.

Apr. 6, near Lincolnton, N. C., Long Shoals Cotton Mills, Inc. $600,000

COTTON YARN MILL. The danger of relying on partial coverage by sprinklers is illustrated in this case. Fire originated at a compressor in a sprinklered basement air compressor room of this partially sprinklered 100 ft. by 500 ft. 1-story brick, wood-joisted cotton mill. One half of the building had a full basement — the other had a subfloor crawl space. The basement air compressor room was separated from the subfloor space by a wooden wall. There was no storage of combustibles in the subfloor area.

The fire jumped from the compressor to dust on the ceiling and flashed throughout the compressor room. An employee, who saw the fire start, gave the alarm and then used extinguishers with other employees to aid the compressor room sprinklers in extinguishing the fire. It was then found that the fire was also burning in the unsprinklered subfloor space which it had entered by means of cracks in the wooden wall. The heat and smoke made it impossible to reach effectively the fire's seat. Fire fighting by the responding fire companies included drilling holes in the floor and using fog nozzles and cellar nozzles through the holes. This was abandoned soon after a cellar nozzle was burned off a hose line. Eventually the fire burned through the flooring. Large quantities of heat from the subfloor fire spread through floor openings and operated about 650 sprinklers. Since the water supply to sprinklers was capable of supplying only 25 sprinklers satisfactorily, the sprinkler system was unable to halt the fire.

July 27, Taunton, Mass., L. Grossman and Sons, Inc. $350,000

BUILDERS' SUPPLY AND EQUIPMENT WAREHOUSE. The gamble that is taken when small areas of otherwise completely sprinklered buildings are left unsprinklered is illustrated by a fire that heavily damaged this 45 ft. by 306 ft. 3-story wood-joisted warehouse. The building was completely sprinklered except for the canopy over the loading platform. The space beneath the platform was sprinklered. The fire started on the platform where a large amount of combustible materials was stored.

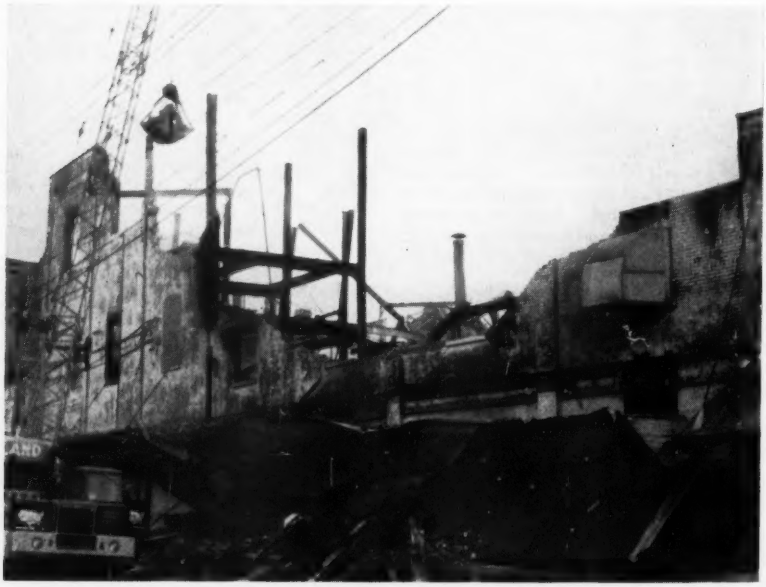
On July 27, a passerby discovered fire burning on the loading platform. At 9:50 P.M. a box alarm brought fire fighters who discovered flames involving not only the platform, but also the asphalt building siding above and a sprinklered, exterior wood enclosed elevator shaft that communicated with the platform and all stories. A general alarm was sounded at 9:45 P.M. and a call for mutual aid was sent at 9:58 P.M.

There was no fire department connection to the sprinkler system. With flames involving most of one side of the building the fire department placed many hose streams in operation. Water supplies for sprinklers and hydrants consisted of a 10-inch looped yard main with three 10-inch connections to two 12-inch street mains. A static pressure of 60 pounds at grade level provided a 38-pound pressure on the top line of sprinklers. The high capacity mains with the very desirable high top line pressure indicated that the 1905 schedule of 80 sq. ft. per sprinkler system should have been successful had there been a fire department connection.

Pumpers supplying 24 2½-in. lines deluged the building with so much water that the pressure was reduced to the point that the attic sprinklers above the eave line were robbed of all water. Forty-four sprinklers held flames out of the first floor. On the second, 3 sprinklers kept the fire out while on the third, 67 were required to keep flames at bay due to the reduced water pressure. In the attic 250 sprinklers operated but since no water was discharged the roof was lost. The heavy use of hose streams accounted for the heavy contents loss.

Private Water Supplies and Fire Pumps

In 256 of the 331 large loss building fires in 1959 there were no private water supplies or fire pumps. In 39 cases this lack of adequate private water supplies was a factor in the outcome of the fire. In 10 other fires the private water equipment available contributed to restricting the extent of the loss.



William F. Pflanz

That the most effective time for water application is as soon as possible in a fire situation is clearly shown by this fire.

In a Reading, Ohio, rendering plant there were two reservoirs storing 374,000 gallons of water for fire use. At the 134,000-gallon reservoir an automatic electric-driven 750 gpm pump was mounted making a 3-hour supply at 750 gpm. At the 240,000-gallon reservoir a 1500 gpm manually operated steam fire pump was located providing a 2 hr. and 40 min. supply at 1500 gpm. All of this water was to back up a 50,000-gallon gravity tank. Thus the total capacity was capable of supplying 75 sprinklers for approximately 3 hours.

Even with all this water the Darling and Co. plant was largely destroyed on April 17 when tallow overflowed a vat and was ignited by electrical equipment.

The fact that the place where the fire started was one of the several small unsprinklered parts of the otherwise sprinklered plant prevented immediate control of the fire. However, had the fire pumps started, sprinklers could probably have kept the fire from adjacent sprinklered areas. The 750 gpm automatic fire pump had been shut off before the fire for some unknown reason. The 1500 gpm steam fire pump was not started until later in the fire. The gravity tank soon became empty as heat spread through the plant opening over 450 sprinklers. All the plant water and all the plant men couldn't save the building by then.

Fire Pump Failures

In 6 cases failure of fire pumps to operate properly was a factor in the fire. The 6 fire pumps failed for the following reasons: 2 pumps suffered power failure during the fire; two failed due to substandard installation; one was not operated during the fire and one froze after the electric heater in the pump room was stolen.

Water Supply Failures

The 5 water supply failures were due in 3 cases to an inadequacy of the supply, and in 2 cases to an insufficient number of yard hydrants.

Jan. 16, near St. Johns, N. F., Newfoundland Atlantic Hardboards Industries Ltd. $750,000

HARDBOARD MANUFACTURE. A cold day, a stolen electric heater and a six mile fire department run over roads only partially cleared of the 5-ft. snowfall wrote the end of this completely sprinklered ½-acre wooden manufacturing plant.

The plant fire pump was mounted without a bypass in the water main to the sprinkler system. The pump house was heated by an electric heater. The heater had been stolen sometime before the fire and this loss had not been detected.

A fire was discovered immediately by an employee who quickly telephoned the alarm to the fire department. The normal 10-minute run to the building was doubled by the snowbound road conditions. With ice in the fire pump the water for sprinklers was blocked. The fire spread quickly across the dust on structural members and there was nothing to halt the building's destruction.

Mar. 3, Patoutville, La., Enterprise Sugar House, et al. $537,000

SUGAR HOUSE. Fire pumps of the horizontal centrifugal type are required to have two reliable priming supplies when operating from suction according to NFPA Standard No. 20, "Standard for the Installation of Centrifugal Fire Pumps." This fire demonstrates the reason for this requirement.

Lightning hit the roof of this ¾-acre, high 2-story metalclad sugar house during a 4:00 to 5:00 A.M. thunderstorm. The bolt started a fire. The fire operated sprinklers which, supplied by a 50,000 gallon gravity tank, were holding the fire. The gravity tank supply was backed up by a 250,000 gallon reservoir. To get the water from the reservoir to the system a 1,000 gpm fire pump driven by a gasoline engine was installed. The pump was manually operated and a priming connection for the suction line was installed from the gravity tank.

The fire was discovered by a neighbor who told a nearby sugar house employee. Together they went and told a nearby assistant overseer. The overseer rang his farm bell while one of his family telephoned the sugar house superintendent. It was 6:00 A.M.

During the time it took for the alarm to be given and for the plant employees to start on their way, the sprinklers, fed by the gravity tank, were holding the fire. On arrival of the plant employees, hose lines were put into operation. They proved of little value due to the weak water supply now available from the gravity tank. The fire department was now called.

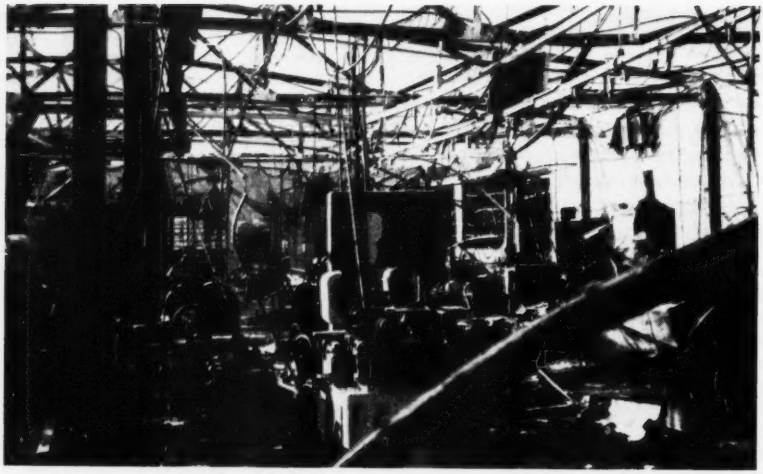
A decision was made to start the fire pump. While the engine started without a hitch, suction could not be accomplished since the only priming supply for the pump was the now depleted gravity tank. There was no secondary supply for the priming water. With no water discharging from sprinklers the fire was able to spread rapidly and by the time water could be carried to prime the pump manually, the fire had opened 650 sprinklers.

Requirements of NFPA No. 20 allow a priming bypass from a gravity tank as a secondary priming supply only. In this case a separate priming tank of approximately 500-gallon capacity connected to the pump by a 4-inch pipe would have been sufficient as a priming supply.

Nov. 1, Blissfield, Mich., Blissfield Manufacturing Co. $850,000

Four days after a sprinkler contract was signed, this 2-acre, 1-story refrigeration equipment manufacturing plant was heavily damaged by an $850,000 fire. The fire broke out on a Sunday afternoon when the plant was locked up and was beyond control when discovered by a neighbor. There was no watchman or other private fire protection.

Blissfield, Mich., is a town of 2,000 and this loss of 175 jobs was sorely felt. At an emergency citizens' meeting to try to determine what could be done to help keep the plant in this town, the company president had this to say:



Ashley Gunn

Destruction of this refrigeration equipment plant in Blissfield, Michigan, put 175 people out of work. A contract for sprinklers had been signed four days before the fire. See report on the previous page.

"I like Blissfield. It's a fine friendly town. And we have done pretty well here. Our plant has grown to eight times the size of the original building erected for us by the Blissfield Industrial Building Corporation.

"Like most small towns, the location of a new industry in your town poses some problems. It requires power and water. On the last, we have not had an adequate supply. In 1952, I began asking your council for a larger pipeline so I could install a sprinkler system throughout the plant to guard against fire.

"I kept asking for it, year after year, and got nowhere. When I asked for it the last time, the council agreed I needed it, according to the Bureau of Inspection standards to get enough pressure, but said they had no money. So their attorney and our attorney got together, and worked out a plan whereby I could pay for the materials and installation as work was done, and the village would buy back the line from me in two years.

"Last Saturday, the 10-inch main finally was hooked up. On Wednesday, we signed a contract for the sprinkler system, which meanwhile had gone up in price from around $13,000 to more than $23,000.

"It was too late.

"Sunday's fire will cost us close to a million dollars to replace the building at today's costs, and the machinery which was buckled by heat or smashed when the roof fell in.

"I should like to remind you that the greatest contribution any factory gives to its town is not, after all, the share of the local tax burden it can assume. It is, instead, the amount of employment provided, and the pay roll which comes back to the municipality and its business firms in the form of new homes, taxes, rent, food purchases, new cars, clothing, and all the rest. This, we feel, is substantial contribution to any community.

"You say: 'What can we do to help you?' and I say, you can help us most by being understanding of our needs, of the people who work in our plant, to be treated equally in the consideration you give to other citizens."

Fire Brigades

In the 296 large loss fires where there were no private fire brigades, this absence was a factor in the outcome of 57 fires. In 10 cases the fire brigades did all that could be expected. There were no cases where the fire brigade, because of poor training or insufficient equipment did not perform satisfactorily.

Standpipe and Hose Systems

In 249 of the large loss building fires no hose or standpipe systems were present. Of the 33 buildings where standpipes and hose were present, 7 systems were not a factor in the outcome of the fire as no one was present to operate the systems. Two systems were used to extinguish or assist in control of the fires.

Twenty-four systems failed to operate or were operated improperly. In 10 instances the fire was too far along on discovery for the hose systems to be effective. In 6 cases the fire spread too fast for effective use of the system, in 3 cases there was a poor or inadequate water supply; in 1 case the lack of maintenance made the system useless; in another the fire was burning in a concealed space out of reach of hose streams, in another the hose was deteriorated, one hose was mounted too far from the fire, and finally one hose was improperly used.

June 15, York Twp., Ont., Dominion Stores Ltd. $1,214,500

GROCERY WHOLESALE WAREHOUSE. A case of wooden "strike-anywhere" matches was accidently dropped. It ignited and fire quickly involved the entire shipment of matches stored with other grocery store supplies in the unsprinklered 5.8 acre 2-story masonry, wood-joisted building. Instead of calling the fire department at once employees

Oregon State Fire Marshal

Faulty operation of an electric fan motor was the apparent cause of fire that broke out on top of a 75-ft.-long veneer dryer in the Oregon Plywood Corp. Employees of this Sweet Home, Oreg., concern turned on the deluge system installed inside the dryer but since the fire was not in the dryer the deluge system had no effect.

At least four 1½-inch standpipe hoses were placed in operation by employees but the fire jumped to the wood roof and spread so rapidly that the hoses had to be abandoned. In an effort to keep the fire from the finishing and storage end of the 1¾-acre L-shaped wooden building employees manually lowered one section of a 2-section draft curtain (¾-inch plywood) but were forced out of the building before they could lower the other section. The employees had not been organized into a fire brigade. While they took definite action in this case, their help was not as effective as if they had been carefully trained and prepared before the fire on June 12.

Flames spread so rapidly through the undivided building that several employees were trapped and were forced to leave through windows. The damage amounted to $538,000.

San Luis Obispo Fire Department

An early morning fire destroyed this auto parts store and attached bowling alley. Attempts to extinguish the fire with portable fire extinguishers in the bowling alley were ineffective due to the fact that fire originated in the empty store. See the story on the next page.

tried to quell the spreading flames with standpipe hoses and extinguishers. The employees were unable to utilize this equipment successfully due to their lack of experience in handling and using the equipment and because of their unfamiliarity with a fire in progress.

Portable Fire Extinguishers

In the 331 large loss building fires of 1959, 4 occurred in buildings without portable fire extinguishers. There were no data on extingushers in 19 cases. In 308 cases portable fire extinguishers were present. In 252 of these fire extinguishers were not a factor, either because the buildings were unoccupied at the time of the fire, or because the extinguishers were not used for one reason or another. In 5 of the remaining 56 cases extinguishers performed their function satisfactorily.

In 51 cases the use of portable fire extinguishers was not successful in controlling the fires which ultimately resulted in large losses. Most frequently a combination of circumstances is responsible for such experience but the principal factors appear to be: (1) fire too advanced on discovery for effective control by extinguishers (in 18 large loss fires this condition was evident); (2) use of extinguishers of inadequate capacity (evident in 18 of the large loss fires); (3) use of the wrong type of extinguishers for the class of fire involved (true in 12 of the large loss fires); (4) fire burning in concealed spaces beyond reach of extinguishers in 2 instances, and (5) fire spreading too fast for effective control in one case. Of course, hundreds of fires are put out annually with extinguishers, are never reported, or never become large losses.

Aug. 17, San Luis Obispo, Calif. Standard Auto Parts Store et al. $250,000

AUTO PARTS STORE, BOWLING ALLEY. At 1:30 A.M. workers finished loading a truck in the Auto Parts section of this store and left. The building was now occupied only by the owner of the bowling alley and his son who were working late at the alley. Sometime before 2:20 A.M. they smelled smoke and on investigation found fire had broken through a lightly constructed partition and into the bowling alley. Unaware of the fact that the seat of the blaze was in the auto store they attacked the fire with a 2½-gallon soda-acid (Class A) and a 5-pound carbon dioxide (Class B) extinguisher with no noticeable results. After this attempt failed they then called the fire department.

By the time the fire department arrived the delayed discovery and the further delayed alarm had given the fire time to spread further into the open area of the bowling alley and time to spread rapidly over the combustible fiberboard ceiling.

On investigation after the fire it was learned that one of the auto company employees could not account for the way he had disposed of his cigarette.

Protection of Records

Throughout the year there were cases of serious loss of records. Two of these (illustrated in the next two picture stories) show the need for protection of irreplaceable records. Whether it is a 10-year series of research records, a history of court cases, or irreplaceable business papers they should be protected by record protection equipment as outlined in NFPA Standard No. 232, "Protection of Records."

Abbass Studios

It had taken three years to compile the new county reassessment. The entire set of reassessment records were just more fuel to the flames that destroyed this 1901 stone and wood-joisted county building in Sydney, N.S. Other unprotected records lost included personal law libraries, reference books, and court and inquest records on the second floor and the 16,000 volume Cape Breton Regional Library that was destroyed when the flames finally burned their way into the basement.

The fire started on Nov. 12, about 2 P.M., when roofers, repairing the copper eaves, accidentally ignited the interior of the vacant attic with a plumber's torch. Smoke alerted a man working in a second floor office, who, on investigation, discovered the well-advanced attic fire. After the alarm was given, employees rushed to pile as many records as possible into the three fire-resistive record vaults. The employees were forced to flee when the roof started to collapse, just fifteen minutes after the alarm. The records that had been placed in the vaults survived, preventing a complete loss of all county records.

J. C. Hopewell, Jr.

Record protection equipment in a combustible unsprinklered building is a must. At 5:47 p.m. on Nov. 11 in Alexandria, La., a neighbor spotted a fire that had been burning undetected for about an hour. With no warning, the fire burned the roof off this 1¼-acre, 1-story brick, wood-joisted office housing nine departments of the U.S. Department of Agriculture. The loss was reported at $450,000, including some $200,000 to contents and records. No information is available as to the actual replacement cost of the records.

Summary

The foregoing examples should make quite clear the point that merely the *provision* of private fire protection equipment is not adequate to prevent large loss fires. The proper *maintenance*, and *operation* of this equipment are necessary corollaries.

Looking at these cases of fire equipment failures should not obscure the fact that thousands of fires are successfully extinguished by sprinklers, by extinguishers, by hose systems and by fire brigades. The danger of not providing this equipment is emphasized below.

November 4, 1959, Regina, Sask., Canadian Aircraft Co. $413,000

A 19-year-old youth bought an airplane in 1934 and started a crop dusting outfit. He did so well that by 1959 he had a permanent staff of seven (three pilots, three mechanics and a secretary) with a seasonal need for a maximum of twenty-five pilots. He operated the largest crop-dusting and charter service in Saskatchewan. In 1940, he leased a 112 ft. by 265 ft. wooden hangar which housed his own 13 planes, 3 trucks, a tractor, company car, tools, office and living quarters. Also housed in the hangar were 4 other aircraft, 4 other trucks and 29 other automobiles. He did not own or ask for an automatic sprinkler system (value of one small airplane), an automatic fire alarm system (value of one truck) or record protection equipment (value of a set of mechanics' tools).

At 4:11 A.M. on Nov. 4, police cruising in the area saw flames coming from the hangar. They radioed the alarm and then assisted this man and a pilot from their hangar apartment windows. Neither man could escape through his door as the doors opened into the hangar proper and escape that way was cut off by flames. The fire department found that the delay in discovery had been long enough to prevent saving the building.

The fire, which started from a faulty oil-fired heating system, burned into the hangar from its not cut-off lean-to.

With all company records destroyed and all his equipment ruined, this uninsured owner finds little hope of ever being able to rebuild his business.

1959 Large Loss Building Fires —

Public Fire Protection

Fire departments in the U.S. and Canada vary from city to city as to their training, equipment and operational procedures as well as in manpower allotments, organizational policies and financial inducements. Each year thousands of fires are handled by adequately trained and properly equipped fire

Nat. Def. Photo

The futility of relying on manual fire fighting efforts in a large building with nonfire-stopped walls and concealed ceiling spaces, is shown by this picture. Had automatic sprinklers been installed in this Halifax, N. S., large naval dormitory then the fire in a large rag storage bin would have been discovered promptly, the sleeping occupants alerted, and the fire controlled with less water than is shown in the air at the instant the picture was snapped.

The fire in the storage room burned undetected for at least 30 minutes on a cold Friday (Feb. 27) night. It was finally discovered at 3:05 A.M. by the fire sentry. Whether the fire was started by a cigarette or from spontaneous ignition is now academic. The fire sentry promptly pulled the base fire alarm box and then activated the building fire alarm system.

Many of the 127 sleeping occupants thought the alarm was just a happy, late homecomer's prank and rolled over and went back to sleep. This error was not fatal in this case, as the smoke spread relatively slowly and allowed for a room-by-room search. In one wing smoke-spread made it necessary for several men to utilize their fire ropes to escape. Fortunately, the fire had not yet broken through the outside lower windows to make this exit route impossible.

fighters. Unfortunately, also each year there are large building fires, some of which are the direct result of faulty fire fighting practices. No criticism of any specific fire department is intended by this report. On the contrary, these stories are used to illustrate questionable practices with the hope that they will be entirely eliminated from present-day fire department procedure.

This section will also illustrate some of the hazards that face the fire service, so that a better understanding of the difficulties and limitations of manual fire extinguishment will result.

Wide World

Sprinklers and the Fire Service

The role sprinkler systems play in connection with fire department handling of fires in buildings so equipped is of great importance since most sprinklered buildings involve either a high life safety hazard or a high property damage possibility. By failing to appreciate the value and importance of maintaining effective water supplies to operating sprinklers, fire fighters can be responsible for permitting fires within sprinklered properties to spread beyond sprinkler control. The most common mistakes are: (1) the practice of diverting the water needed for sprinkler operation to hose streams, instead of reinforcing the sprinkler system through the use of fire department connections to such systems and (2) the practice of closing the sprinkler valve too soon. (See Private Fire Protection for other cases.)

The following case demonstrates what happens when a sprinkler system is shut off too soon.

Jan. 26, Seneca Falls, N. Y., Seneca Knitting Mills, Inc. $1,995,500

FULL PROCESS KNITTING MILLS. Improper fire department use of sprinklers is illustrated in this case where a fire chief was talked into allowing sprinklers to be shut off before the fire was out so that water damage to stock would cease. By doing this, the entire plant, all its machinery and all its stock, was destroyed and its 330 workers were put out of a job.

On reporting for work Monday morning employees discovered dense smoke coming from a sprinklered wooden bin of several thousand pounds of mixed textile fibres beside the card room. The fire department was called but because of the dense smoke was unable to complete extinguishment of the fire being held in check in the bin by sprinklers. Because of the fear of excessive water damage employees insisted that the fire chief shut off the sprinklers. This he did, after which the fire spread rapidly out of control.

The sprinkler valve was opened twenty minutes later as soon as it was seen that the fire was spreading, but by then so many sprinklers had fused that the public water main (the only supply for sprinklers and hose streams) was overtaxed. Fire department connections to the sprinkler system were available through which the most effective use could be made of the limited water supply, but unfortunately these were not used.

The fire continued to spread out of control in the section of origin and went through unprotected openings in a fire wall to the remaining two-thirds of the plant.

Spontaneous heating of the fibres that had stood in the bin for two days after being sprayed with a red oil-water emulsion was the probable cause of the outbreak.

Alarm Response

The adequacy of fire department response to the alarm of fire is an important consideration in the study of large loss fires. In the last few years failure to assign an adequate number of men to first alarm response apparatus coupled with failure to call extra help promptly when needed has resulted in the old problem of "too little — too late." This is just as dangerous as delayed initial discovery or delayed alarm.

The advent of radio equipped apparatus has made it possible to provide a full, effective response on both first and subsequent alarms; but many communities, even those with radio, still fail to make full use of their facilities.

In 38 cases time element in the response of the fire department was a factor in the spread of fire. In 24 of these cases the running distance was exceptionally long. In 5 cases response was delayed by traffic congestion or parked automobiles, in 2 cases by icy or slippery roads, and in one case by simultaneous alarms.

The advantage of full first alarm response is shown clearly in this case of adequate fire department response.

Mar. 13, Aurora, Ill., Jennings Terrace Home, 4 killed $260,000

HOME FOR THE AGED. It is indeed fortunate that 16 paid fire fighters were provided by Aurora, Ill., to respond. These men arrived on 2 pumpers and an aerial ladder 2 minutes after the alarm in this home for the aged, was sounded. They were thus able to rescue three elderly men (two 90 and one 78 years old) who leaped five stories into a life net, and at the same time to set up ladders to rescue two others and start fire fighting operations.

Means of escape from the top story of this 5-story stone, wood-joisted "home" included

United Press International

Four people died in this Old People's Home, but adequate first alarm fire department response saved seven others. See story on this page.

three open stairways, an elevator and two slide escapes. But these exit routes were not accessible to many of the fifth-story occupants because of smoke and heat in the open stairways and corridors. One slide escape could have been used by some of the victims but was not. Four men died in their rooms.

The fire occurred Friday, March 13th, at 9:21 A.M. when most of the 88 elderly occupants, including the eight attendants, were in the first story in dining and lounging rooms. Several of the 15 elderly gentlemen who occupied the top story, however, had returned to their rooms.

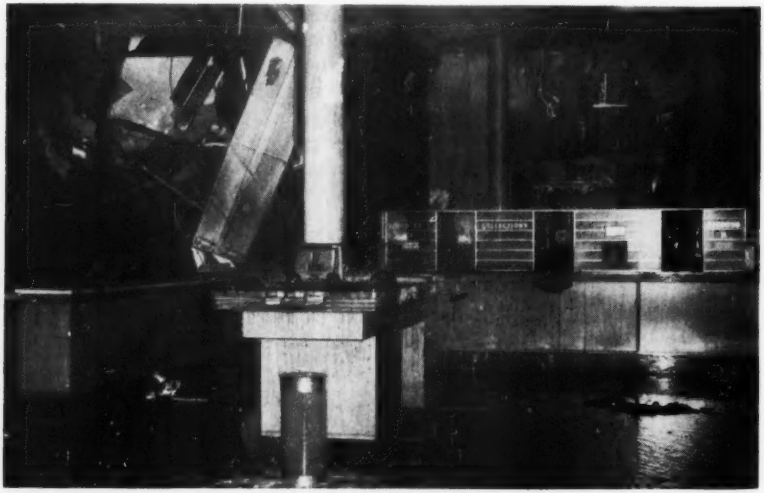
Starting on the fifth story, the fire entered and spread throughout the undivided attic, and extended from the fifth story to lower stories by means of the open stairways.

A contract had been let for complete sprinkler protection for the building but when the fire occurred the system covered only in the basement and first story.

The cause of the fire was not determined, and there is some question as to whether the fire department was called as soon as the fire was discovered. It is known that flames were coming from fifth-story windows of one wing of the T-shaped building before the fire department was notified.

Manpower

Fire Department manpower deficiencies were noted in 43 fires; 27 due to insufficient manpower; 10 due to inadequately trained fire fighters, and 4 to organizational failures which resulted in failure of the department to bring its full force to bear on the fire.



Daily Interlake

An employee closing a clothing store in this 75 ft. by 142 ft. 3-story masonry, wood-joisted Kalispell, Montana, bank building smelled smoke. When he tried to telephone the alarm, he found that the fire in the rear of the basement storeroom had burned the telephone wires. The alarm, phoned from an adjoining building, was finally given at 5:15 P.M.

A 750 gpm pumper was immediately dispatched with the two paid men on duty. Eight minutes later another 750 gpm pumper with three men on board responded. Seventeen minutes later another man took the old 1000 gpm pumper to the fire. These six men were assisted by civilians until one hour after the original alarm when help began to arrive. Seventeen men on a 750 gpm pumper, 9 men on a 750 gpm pumper, 12 men on a 450 gpm pumper, and 6 men on a 300 gpm pumper arrived between 6:15 P.M. and 6:30 P.M.

The lack of adequate fire department manpower when the basement fire was first discovered, combustible fibreboard tile ceilings, and other combustible interior finish all combined to give the fire a good head start. The Sept. 14 fire caused $1,376,000 damage.

Jan. 14, Washington Court House, Ohio, Grace Methodist Church $340,000

CHURCH. This Ohio town of 11,000 persons had a fire fighting force of 8 paid men and officers, a chief and 16 volunteers. On duty at any one time were two men and an officer.

The church building involved in this incident had just been refinished inside with new rugs and new coats of varnish. A low-pressure gas-fired heater had been installed in the basement furnace room in the fall. Some trouble had been experienced with this equipment. On the day before the fire church women had complained of a lack of heat. Sometime after 5:30 P.M., after the last church official had left, a fire started in the basement furnace room.

About 3:00 A.M. a passerby saw the fire and reported it in person at the police station. The police investigated and gave the alarm at 3:11 A.M. This additional delay gave the fire extra minutes to spread so that when the meager force of two men and an officer arrived, the church was fully involved. The first responding off-duty member of the fire department arrived 13 minutes after the alarm; thus at 3:24 A.M. four fire fighters were working. Eventually, men from eight surrounding towns placed six 2½-inch hose lines and four 1½-inch hose lines in service.

The unsprinklered church with its $26,000 worth of art glass was destroyed with one-half of the church school building. Flaming brands from the fire damaged a service station, four dwellings, two small garages and 15 parked automobiles.

It will cost over $750,000 for replacement of the building in like kind and quality.

Aug. 16, near Gravenhurst, Ont., Muskoka Beach Inn $250,000

SEASONAL HOTEL. Ring the fire alarm in a popular resort area on a pleasant mid-August Sunday afternoon and see how many men respond. It may be only 10 or 12. In this case only 8, to round out a series of factors which usually spell total building destruction.

First: There was no adequate automatic sprinkler or alarm equipment installed in the hotel involved.

Second: Though the hotel was fully occupied, no one happened to be in the basement at the time the fire started.

Third: When smoke was finally detected, the investigating party of three chose to attempt to use portable extinguishers on the fire, but the smoke and heat held them at least 50 ft. from the flames.

Fourth: The extinguishers they used on the Class A fire were a 5-pound Class B-C carbon dioxide extinguisher with a range of 10 to 12 feet, and a Class A pump type which, it is reported, had "no effect."

Fifth: No one had trained the staff in emergency fire fighting procedures and no one had set up an alarm procedure.

Sixth: No one had tried to limit the combustible fibreboard ceiling area or replace the flimsy partitions in the basement.

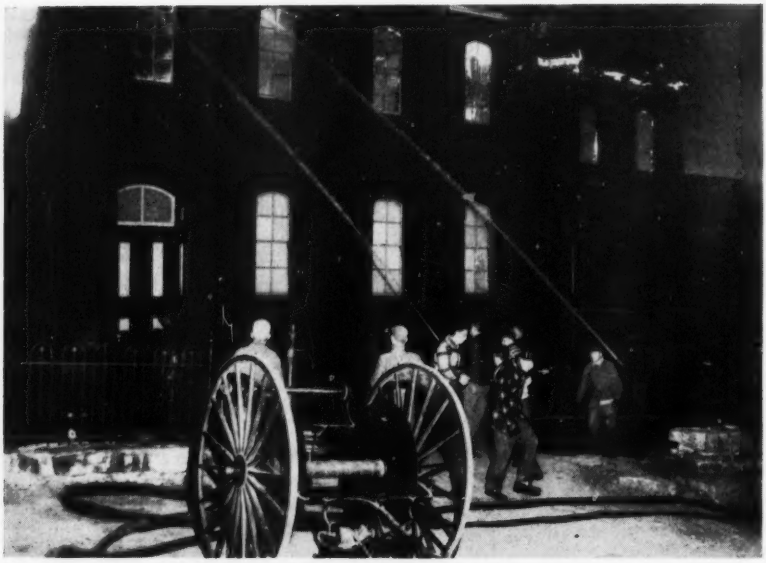
Seventh: When the alarm was finally rung at the fire department 4 miles away, only eight men responded to operate the pumper. For these eight men to be expected to take suction efficiently from a lake 300 feet away for a fire which, by then, extended well through the building was quite impossible. To some of the guests who were swimming at the time the fire broke out, "being left with just the clothes they wore" was small consolation.

Equipment

The following equipment deficiencies were reported by the fire chiefs as being a factor in 98 fires. Forty-eight reported lack of or insufficient aerial ladders, 29 complained of inadequate pumper capacity, 19 noted the need for special service equipment and 2 reported equipment breakdown at the fire scene.

Nov. 3, Welch, W. Va., National Guard Armory $512,500

The National Guard was routed on Nov. 3, when fire started in one of its armories which had no fire protection of its own, and was located in a town which could not provide adequate protection. A fire burned undetected in the basement of this 35 ft. by 65 ft. 2-story concrete-block, wood-joisted armory while the janitor did some typing on the second floor. Smelling smoke, the man proceeded to the first floor and as he opened the door to the basement was greeted by a wave of flame. Realizing the fire was well beyond portable extinguisher capacity, he ran outside and up a hill to a commercial radio transmitter site to telephone the alarm. The fire department pumper arrived and used



Thomas C. Wigoda

Inadequate pumper capacity and lack of any ladder equipment at the early stages of this Donaldson, Pa., public school building fire allowed flames to spread unhampered up open stairways to destroy most of this large township school.

The $500,000 fire was discovered at 4:30 A.M. on Feb. 6 by a neighbor who stopped a passing motorist. The motorist on hearing of the fire drove to the fire station and sounded the siren. The cause of the blaze was undetermined.

The Woody's Studio

A 500 gpm pumper was all that responded to this Welch, W. Va., armory fire (see previous page).

its 500 gallons of water in an attempt to extinguish the basement fire. The attempt failed. The pumper was refilled and returned to protect exposures while the $450,000 of government arms, ammunition and field supplies were destroyed in the unsprinklered building. All written records of this National Guard Company were also destroyed in the blaze, as they had not been stored in fire-resistive record containers.

Water Supply

Inadequate water supply was a factor in 82 fires. In 56 cases the fire department reported the need for more water. In 11 cases there was no public water supply; in 12 cases there was no "other-than-public" water supply and in 3 cases the "other-than-public" water supply was inaccessible for fire department use. In 8 of the 56 poor supply cases, the water demand to serve both manual fire fighting and sprinkler needs was inadequate.

Hydrants

At the scene of 26 of the 1959 large loss fires, fire chiefs reported there were not enough hydrants available. In 9 additional cases the hydrants were frozen or defective, and in 1 other the hydrants were not usable as they were too close to the involved building.

June 5, Cedar Grove, N. J., Pompton Avenue School $500,000

GRADE SCHOOL. Fire fighting was delayed 20 minutes when the responding fire fighters found two hydrants defective. One was partially blocked inside with stones and dirt and the other had a mechanical defect which prevented its operation.

Smoke was discovered in the section of town near the school by a patrolman in a police cruiser. He immediately radioed for help and another car-equipped policeman responded. They both checked the area building by building until one spotted a red glow and found smoke issuing from the 2-story brick, wood joisted school building. The

Department of Public Safety

The effective use of fire walls is shown graphically in this picture of a $605,000 fire in a large canning plant in Sunnyvale, Calif. The planning shown in the design phase of the building was not carried through to the planning of the plant's water supply.

The fire in the 1-acre wood-framed, metal-clad labelling building originated about 5:40 P.M., Jan. 20, in the second story while the plant was occupied by a few maintenance men.

On being advised of the fire, an employee in the attached boiler room shut off electricity and gas to the boilers, thereby stopping the private electric well pumps which supplied yard mains. He then headed for the basement of the labelling building intending to open the valve to the city water supply (closed during off-season) but was temporarily prevented from doing so by the fire. He was finally able to make his way to the valve and open it. Unfortunately this 10 minute delay had forced several responding pumpers to disengage from the yard hydrants they found nonproductive and to lay new lines to operating hydrants 1300 ft. away. The delay also prevented fire fighters from keeping fire out of the engineers' office building, the boiler room and from saving the water cooling tower mounted on the roof of the attached main canning building.

Robert W. Mannion

A public hydrant over ¾ of a mile away and a small brook capable of supplying a single 1½-inch hose line were the only water supplies for this 80 ft. by 140 ft. 1- and 2-story masonry, wood-joisted metalworker manufacturing optical instruments in Danbury, Conn.

The lack of automatic sprinklers to detect and extinguish the fire and of an automatic fire detection system to detect the fire allowed it to burn undiscovered until a milkman passing about 5:20 A.M. on Jan. 23 happened to see the blaze. He telephoned the alarm from a nearby diner. With the water supply so weak, the flames had complete control of the plant before relay operations could be instituted. The $250,000 loss was total.

alarm was then transmitted to the fire department immediately.

With the further delay caused by the defective hydrants, the flames spread out of the basement store room of origin and spread to upper floors by means of foul air ducts that terminated in the attic.

Board of Fire Underwriters of the Pacific

This private hydrant was the main source of water for fire fighting at a building supply company's lumberyard fire March 19, near Phoenix, Arizona. The main "steamer" connection faced the parked cars and not the street as it should have. Thus located, it could not supply all the water available from the public 10-inch street main which fed it. The hydrant placement was not the only problem of the fire as one engine overheated and the water pump pulley failed on another.

The fire was believed to have started when a 20 mph wind blew sparks past the improperly fitted screen on the refuse burner.

Hazards of Fire Fighting

It should not be forgotten that in each of the fires reported in this story, fire fighters faced the normal hazards of manual fire fighting.

One or more of the following hazards to manual fire fighting was a factor in each of 220 fires: heavy smoke (71); high winds (48); blank walls impeding access (39); explosion during fire (37); extreme cold, ice, or snow (34); congested buildings impeding access (19); height of building impeding access (16); explosion preceding fire (9); toxic gases and vapors (9); explosion at start of fire (8); locked doors impeding access (7); leaking gas mains (7); flowing flammable liquids (7); railroad tracks impeding access (7); no basement entrance impeding access (6); yard storage impeding access (6); body of water impeding access (4); barred windows impeding access (3).

1959 Large Loss Building Fires —

Conclusion

The only requirement for a large loss fire is that it destroy $250,000 worth of property. This can happen in a closet full of expensive radar equipment, on a floor of a building or it may mean the destruction of several buildings. Large loss fires can be prevented by limiting the value subject to a single fire or by providing protection to limit fire spread. If values of $250,000 are worth protecting, then the protection must be provided by someone.

Responsibility for Large Loss Fires

The *architect* has the responsibility to provide a safe structure. Undoubtedly he intends to have the building he designs or remodels standing for a long time. The calculations for foundation strength, earthquake protection and wind loading normally receive ample consideration, but all too often considerations of fire safety — value subdivisions, hazard cutoffs or private protection equipment — are overlooked

Fred F. Feary

The largest mercantile fire loss of 1958 was a July 22 fire in Stockton, California's Smith and Lang Department Store. This $2,434,000 fire completely destroyed the unsprinklered 2-story building as shown above. The building was completely rebuilt in 1959 as a modern 2-story structure. While the owner has utilized windowless walls on the second floor he has protected the building with a complete automatic sprinkler system.

L. Covello Photos

with the result that a building otherwise strong and safe is destroyed by fire.

The *owner or occupant* has the responsibility to preserve his property. He must not only protect and maintain the heating, the plumbing and the exterior finish, but he must also maintain the fire protection equipment provided to limit fire spread. Those who would never yank out a column, open up a foundation, or cut into a pipe without careful thought as to the effect of their action will often, without any hesitation, puncture a fire wall, close a sprinkler valve, remove doors on stair wells, or allow their fire protection equipment to deteriorate.

The responsibility of the *watchmen and guards* should be emphasized. These men often are the only occupants of and are entirely responsible for, a valuable building. During working or operational periods, buildings, for instance, house workers with a payroll worth thousands of times the watchman's salary. During these periods management sees to it that the operations conducted in the building are under the supervision of qualified and highly paid persons, but at night an entire structure may be left in the hands of someone who has not had proper instructions, or proper training. It is during this period that many of the large loss fires occur.

Fire protection officials have even greater responsibilities. Fire chiefs, fire inspectors, fire protection engineers, fire equipment designers and salesmen, must all work together to explain the importance of proper building design and to show the value and adaptability of private fire protection equipment.

Educators — those teaching the engineering sciences, design, architecture, and fire protection — have the responsibility to see that each graduate is properly armed with the basic principles of fire protection, and that each man recognizes the power he commands over life and death through correct or incorrect design. A simple omission of a relatively inexpensive fire door can result in a severe loss.

Insurance agents and brokers hold a similar responsibility to advise their clients on the importance of installing and maintaining a high level of fire safety in their properties, not only in the interests of preventing material losses but also life safety.

It is only through the recognition and acceptance of these responsibilities that proper fire protection will be provided. Once this problem of responsibility is resolved, then the lessons of large loss fire experience shown in this issue of the QUARTERLY can be fully implemented.

Table I

Factors Responsible for 1,964 Large Loss Building Fires During Period 1953-1959

NOTE: The figures in this table indicate the number of times each factor was noted as influencing fire spread or the extent of damage in the 1,964 fires. In addition to the listed items many less frequently occurring factors were also reported. A combination of two or more factors was responsible for most of the large losses. The **boldface** type indicates the 1959 experience. The lightface type in the column headed **"Total"** indicates experience during period 1953–1958 whereas in the remaining six columns the lightface type indicates total 1953–1959 experience.

Principal Structural Defects Influencing Fire Spread	Total		Industrial	Mercantile	Storage	Residential	Educational	Misc.
FIRES ANALYZED 1953-1958	1633	...	565	324	288	82	89	285
Fires Analyzed 1959	....	**331**	**107**	**89**	**54**	**17**	**18**	**46**
Horizontal Spread								
FIRE DIVISION WALLS								
Too few in attics	181	**54**	22	92	15	23	36	47
Too few in basements ..	69	**6**	7	31	3	10	4	20
Too few in other stories.	816	**137**	394	159	205	28	41	126
Substandard constructions	78	**7**	17	25	9	6	3	25
FIRE WALL OPENINGS								
No protection for opening	98	**18**	53	19	22	2	5	15
Fire doors blocked open or inoperative	24	**6**	10	4	6	...	3	7
Substandard protection for openings.....	14	**5**	10	3	1	1	2	2
COMBUSTIBLE INTERIOR FINISH								
Fiberboard.....	74	**32**	21	43	9	5	3	25
Other interior finish....	57	**7**	16	19	3	9	4	13
Oil-soaked floors.....	37	**4**	20	1	2	...	5	13
Vertical Spread								
Stairwells not enclosed...	455	**89**	138	154	79	53	38	82
Elevator shafts open.....	206	**19**	70	51	65	20	9	10
Nonfirestopped walls.....	176	**45**	10	79	9	24	27	72
Conveyor, machinery openings not protected.....	70	**12**	56	4	20	1	...	1
Stairwell enclosure substandard.....	39	**21**	10	28	4	8	3	7
Pipe openings not enclosed	23	...	7	5	2	1	1	7
Elevator shaft enclosure substandard.....	21	**8**	8	9	3	6	...	3
Other openings, no or substandard protection ...	55	**7**	26	10	8	5	7	6
Spread to Exposures								
Congested combustible const., no exposure protection.....	347	**35**	158	45	66	19	3	99
Poorly constructed party walls	83	**16**	11	65	9	7	...	7
Interconnecting passageways, conveyors.....	54	**12**	30	11	14	7	...	4
Ordinary glass windows...	52	**6**	7	24	7	8	2	10
Yard storage between bldg.	30	**3**	13	...	5	...	...	15
Other reasons for spread	77	**36**	41	29	15	5	1	22

Table I — Continued

Principal Contents Influencing Fire Spread

	Total		Industrial	Mercantile	Storage	Residential	Educational	Misc.
FIRES ANALYZED 1953-1958	1633	...	565	324	288	82	89	285
Fires Analyzed 1959	....	**331**	**107**	**89**	**54**	**17**	**18**	**46**
Flammable Liquids								
Escaped from tanks, drums	211	**35**	134	42	35	3	5	27
Escaped from auto, aircraft tanks	49	**6**	8	5	9	...	...	33
In process equip. (1958 and 1959 only)	9	**9**	12	4	1	...	...	1
Container explosion	22	**21**	18	6	11	...	...	8
Escaped from pipes	26	**3**	21	1	1	...	...	6
Other flammable liquid factors	88	**10**	52	11	13	1	1	20
Storage Methods								
Poor stock subdivision	214	**32**	62	57	109	2	...	16
Stock piled too high	78	**30**	19	21	47	...	1	20
Inadequate window clearance	22	**9**	4	9	17	...	...	1
Other storage factors	146	**20**	29	32	70	2	3	30
Housekeeping								
Dust on structural members, etc.	131	**21**	113	7	21	...	4	7
Rubbish accumulations	68	**3**	24	18	14	3	1	11
Other housekeeping factors	53	**15**	45	9	6	2	1	5
Gases								
Natural gas	34	**9**	17	9	4	4	...	9
Acetylene	13	**5**	12	1	1	...	1	3
LP-Gas	12	**5**	3	8	2	2	...	2
Other gases	27	**11**	24	2	7	2	...	5

Principal Private Fire Protection Defects Influencing Fire Spread

	Total		Industrial	Mercantile	Storage	Residential	Educational	Misc.
FIRES ANALYZED 1953-1958	1633	...	565	324	288	82	89	285
Fires Analyzed 1959	....	**331**	**107**	**89**	**54**	**17**	**18**	**46**
Sprinkler Protection								
No sprinkler system	1374	**282**	472	395	292	70	104	323
Complete protection — unsatisfactory performance	114	**11**	84	...	24	5	...	7
Hazard too severe for system installed	24	**1**	22	...	2	...	...	1
Water supply poor or failed	21	**1**	16	...	4	2	...	...
Valves closed for miscellaneous reasons	22	**4**	12	...	5	2	...	7
Explosion damaged system	18	...	17	...	...	...	...	1
Valve closed too soon	10	**2**	9	...	3	...	...	...
Other reasons for unsatisfactory performance	19	**3**	10	...	10	1	...	1

Table I — Continued

	Total		Industrial	Mercantile	Storage	Residential	Educational	Misc.
Partial protection — unsatisfactory performance	29	9	21	4	6	3	1	3
Origin in unsprinklered areas, spread to sprinklered areas	27	5	18	4	4	3	1	2
Valve closed, defective	2	1	1	...	1	...	...	1
Other reasons for unsatisfactory performance	...	3	2	...	1	...	...	...
Fire Detection								
No watchman or automatic detection	932	193	256	303	188	69	88	221
Unsatisfactory watchman service	207	31	98	24	48	14	12	42
Failed to detect fire promptly	153	16	65	18	35	7	8	36
Patrolled outside building only	18	1	6	3	5	1	...	4
Protected area too large	15	1	6	1	1	...	5	3
Asleep	8	1	3	1	4	...	...	1
Other reasons for watchman failures	48	12	31	5	11	3	2	8
Unsatisfactory automatic detection	8	4	5	...	1	1	...	5
Fire Alarm Transmission								
Transmission delayed	309	89	138	76	60	27	18	79
Occupants fought fire	114	34	54	29	31	7	5	22
Telephone wires burned	37	6	12	9	2	7	2	11
Telephone inaccessible	20	3	11	4	3	1	1	3
Watchman fought fire	11	1	4	...	4	...	...	4
Other reasons for delayed transmission	127	45	57	34	20	12	10	39
Fire Brigades								
No fire brigade	209	55	138	18	45	15	8	40
Unsat. performance	69	3	34	1	13	1	3	20
Fire too advanced on discovery	21	...	11	1	8	...	...	1
Insufficient equipment	9	1	5	...	2	...	1	2
Other reasons for unsatisfactory performance	39	2	18	...	3	1	2	17
Portable Fire Extinguishers								
No fire extinguishers	8	2	2	1	4	1	...	2
Unsat. performance	229	51	117	36	44	17	12	54
Fire too advanced on discovery	150	18	73	16	23	12	8	36
Wrong type for class of fire	35	11	15	8	10	2	...	11
Other reasons for unsatisfactory performance	44	22	29	12	11	3	4	7
Standpipes and Hose Systems								
No system	143	40	73	27	34	6	5	38
Unsat. performance	101	25	71	2	14	8	9	22
Fire too advanced on discovery	63	8	41	1	8	2	6	13
Other reasons for unsatisfactory performance	38	17	30	1	6	6	3	9
Special Extinguishing Systems								
No system	59	9	37	5	4	...	...	22
Unsat. performance	8	1	8	1	...	...	...	...

Table I — Concluded

Principal Public Fire Department Handicaps Influencing Fire Spread

	Total		Industrial	Mercantile	Storage	Residential	Educational	Misc.
FIRES ANALYZED 1953-1958	1633	...	565	324	288	82	89	285
Fires Analyzed 1959	....	**331**	**107**	**89**	**54**	**17**	**18**	**46**
Water Supplies								
Inadequate	187	**48**	102	35	44	10	24	20
No public supply	83	**11**	44	11	19	7	5	8
Inadequate water for hose streams and sprinklers	54	**8**	39	...	10	4	...	9
Insufficient hydrants	63	**26**	34	14	16	3	8	14
Equipment and Manpower								
Insufficient equipment	202	**96**	60	66	31	29	27	85
Insufficient manpower	103	**27**	35	41	13	8	6	27
Manpower not properly trained	57	**10**	23	15	12	5	3	9
Fire Fighting								
Heavy smoke	170	**71**	47	94	45	9	6	40
High winds	117	**48**	51	28	24	9	7	46
Explosions preceding fire	90	**9**	61	13	12	2	1	10
Explosions during fire	100	**37**	47	33	22	3	1	31
Access impeded by blank walls	66	**39**	23	46	15	...	...	21
Flowing flammable liquids	35	**7**	26	1	6	1	...	8

Large Loss Fires Not in Buildings

Oregon State Fire Marshal

Cartons stacked too closely together, nonflameproofed tarpaulins, and nonfirestopped pallets lined up so the 20-40 mph gusty wind could drive the flames under and through 200,000 cases of canned peas — these were the principal factors responsible for this July 23 fire in Milton-Freewater, Oreg. Damage was $428,000. A period of high temperatures (over 100°F) and low humidities existed during the week preceding the fire.

There were 9 large loss fires involving property outside of buildings, other than forest and transportation fires. These 9 fires caused 5 deaths and 20 injuries and $6,100,500 property damage.

Three deaths occurred when an offshore drilling platform exploded and burned. One fatality occurred when a coking unit at a refinery exploded, and the last fatality occurred when a truck driver was fatally burned during a butane bulk plant fire. The six other incidents occurred as follows: an oxygen distillation column explosion, a pulpwood pile fire, a refinery coke still fire, a cresylic acid tank explosion, a pier fire, and a fire in a storage yard for cases of canned peas.

Jan. 22, Ponca City, Okla., Cities Service Oil Co. 1 killed $400,000

Refinery Coking Unit. After coke-out men had cleaned one of two adjacent coking units, two pumps were started to fill the units and dephlegmator with oil. Filling completely with oil at startup served to purge the unit of air, permitted pressure test for leaking flanges and furnace plugs, and permitted check of relief valve operation.

By mistake the air vent for the system was not opened before filling started. It was noticed that the filling was proceeding more slowly than usual and that the main charging pump was heating, but these conditions were attributed to the viscosity of cold charging stock and possible plugging of suction screens with coke fines. The main centrifugal charging pump was shut down but a smaller reciprocating pump that pumped oil to the unit through a furnace was kept in operation and the furnace was lighted, to heat the oil and thereby reduce its viscosity.

Finally, the significance of the increasing pressure in the unit was grasped and two men were sent to open the air vent, but before this could be done a violent explosion ripped apart the dephlegmator. One of the two men was killed.

The explosion is attributed to spontaneous ignition of a ram oil vapor-air mixture in the dephlegmator. Ram oil, a light gas oil used to flush out valves, etc. before each startup, has an ignition temperature range of 469°F to 493°F. Temperature near the surface of the hot oil in the dephlegmator prior to the explosion is conservatively estimated at 500°F.

Sept. 30, Hamilton, Ont., Dominion Foundries and Steel Company Ltd. $300,000

STEEL MILL. Pure oxygen for steel making is produced in this plant by the fractional distillation of liquid air. There are three independent distillation units and the product of this distillation is stored in gas holders for subsequent use.

While the plant was in operation at 8:10 P.M. an explosion originated in a distillation column destroying the column and blowing out walls of the "cold box." Last gas analysis had been made at 11:00 A.M. that morning and showed a concentration of 43 ppm total hydrocarbons and 0 ppm acetylene. Gas in holders following the explosion also showed 0 ppm acetylene. Although the cause has not been definitely determined it is thought that acetylene in some form was responsible for the explosion. For example, it may have been due to copper acetylide formed when a small amount of acetylene came in contact with copper tubing. As one of the other distillation units already had been shut down for deriming, the steel plant operations were reduced to 65 per cent of capacity for 2 to 3 weeks until the deriming was completed.

Mar. 12, Brinkley, Ark., Weis Butane Gas Co., 1 killed $250,000

BUTANE BULK STORAGE PLANT. When a butane delivery truck driver went to adjust the position of his truck while it was being filled at a loading rack, he appeared to have forgotten to disconnect the fill hose. The hose was pulled full length and this put a severe bend in the loading manifold before the hose broke. The manually controlled valves on both tank and truck were found open after the fire. The excess flow valve on the tank did not close. It is thought that friction loss from the piping complex reduced the flow and kept it below the operating rate of the excess flow valve. The ignition of this large flow of butane gas was thought to have occurred from the motor of the delivery truck. The truck driver died in the hospital from third degree burns.

The ⅛-of-a-city-block area in which this incident occurred was congested with three gasoline bulk plants, six buildings, the butane bulk plant, two butane railroad tank cars and 21 trucks and cars.

During the early stages a 6431-gallon propane tank and one of the one 15,000-gallon propane tanks ruptured, due to overheating of their shell sections. Then one of the two large 16,000 gallon butane tanks ruptured sending its contents of 13,000 gallons of butane flaming 1200 feet into the air. The overheated tank broke into three pieces, two remaining nearby, but the other, a head

Carl J. Hampton, Brinkley Argus

Wreckage of the Brinkley, Ark., butane bulk plant reported above.

and 1½ courses of shell section, was propelled violently forward, through an unoccupied fish market and into the town's main street. The fish market was destroyed. After this explosion fire fighters and equipment arrived voluntarily from ten towns in addition to the two towns called.

As a result of the explosion the "end of one building was blown out, one building smashed flat, one railroad tank car blown off the tracks, one transport trailer blown upside down." Good fire department operation succeeded in saving three buildings, the three nearby gasoline bulk plants, and thirteen vehicles.

Forest Fires

There were 23 forest fires in 1959 of which each caused a loss of over $250,000. Twenty-two were in the United States — Alaska (3), California (15), Oregon (2), Arizona (1) and South Dakota (1); while one was in Quebec, Canada.

These fires caused an estimated total loss of $38,069,500. Cost of suppression is not included in this figure. For the four fires for which this cost was available, it totalled $1,317,000.

Transportation Fires

There were 46 large loss aircraft fires and one ship fire.

The 46 aircraft fires are summarized in the following article on "Large Loss Aircraft Fires."

Nov. 8, Galenia Park, Tex., S. S. Amoco Virginia, 8 killed $6,000,000

GASOLINE TANKER. A gasoline spill upstream of this tanker being loaded was probably ignited by a tug's running lantern. When fire spread along the gasoline to the tanker an explosion occurred in one of the gasoline barges tied alongside. This explosion threw gasoline onto the ship exploding two of her portside tanks. The ensuing fire destroyed the $6,000,000 vessel, killed eight men and injured 41 others. The call for mutual aid was delayed for an unreported reason. It was reported that over $165,000 worth of foam was used in the fire fighting.

Wide World

A disgruntled United States Forest Service employee is said to have admitted setting a fire that caused $18,773,000 damage in the Angeles National Forest, California (near Los Angeles) on October 13. The fire burned 14,000 acres of watershed covered with brush, scrub oak, eucalyptus and pine trees. Two fire fighters were killed and $1,450,000 was the cost of fire suppression. Damage to nine structures totalled $79,600.

Los Angeles Fire Department

Fire fighting difficulties in brush country are shown in this picture by the steep slopes, narrow trails, and relatively inaccessible homes. On July 10, an afternoon fire started by discarded smoking materials raced through three principal canyons and destroyed 36 dwellings, six automobiles and 184 acres of valuable brush cover in the dry Santa Monica mountain range in the City of Los Angeles, Calif. The danger of erosion after such a fire is clearly shown above.

Los Angeles Fire Department

The problem encountered most in the hill country in and around Los Angeles, California, is that of brush control. With no legal power to make a homeowner cut the brush back 30 to 50 feet from his home the fire department can only suggest. The owner of the home on the right felt his rights being infringed upon and refused. The July 10 conflagration showed clearly the reason for brush removal.

Large Loss Aircraft Fires of 1959

Losses from the 46 large loss aircraft fires of 1959 resulted in 127 people killed and $132,990,000 in damages. Ten of the lives lost in these accidents were to people on the ground while the balance, 117, were passengers and crew members. There were 4 fewer large loss aircraft fires in 1959 than there were in 1958, and the number of deaths decreased by 67, but the aircraft dollar losses increased by $3,440,000.

Twenty of the large aircraft fires were due to crash fires, 12 resulted from in-flight fires that could not be controlled, and explosions in flight and ground fires were each responsible for 7 of the large losses. This is a decrease in the number of crash fires as compared to 1958 when there were 32 and a sharp increase in the number of in-flight fires (from 4 to 12). In 1958 there were 9 ground fire incidents and 5 cases of in-flight explosions.

Crash Fire Incidents

The 20 large loss aircraft crash fires were cases where the impact was not alone sufficient to demolish the aircraft and kill all occupants. In other words, fire contributed to a major degree in the extent of the damage and the loss of life (where there was any). Eliminated from the list of crash fires are two large loss of life crash fires involving DC–3 aircraft resulting in a total of 34 deaths but which resulted from "power-on" collisions into mountains causing impact injuries fatal to the majority aboard (Jan. 8 near Bristol, Tenn., Southeast Airlines, 10 killed; Dec. 2, Montoursville, Pa., Allegheny Airlines, 24 killed). No fires followed the crash of an American Airlines' Electra into the East River near LaGuardia Airport on Feb. 3 (fatal to 65 aboard) or in the case of the Piedmont Airlines DC–3 accident near Charlottesville, Va., Oct. 30, fatal to 26.

A number of other tragic crash fires occurred outside the United States and Canada including the following notable ones:

Jan. 11, Rio de Janeiro, Brazil, Lufthansa Airlines Constellation; 36 killed

Mar. 6, Managua, Nicaragua, TACA International Airlines Viscount; 15 killed

May 20, Ashiya Air Base, Japan, U. S. Air Force C–130; 7 killed

Six of the crash fire incidents are included in this summary analysis as typical of the experience, including three military aircraft accidents, two commercial transport accidents and one airship crash.

Feb. 17, near Pinetown, N. C., U. S. Navy ZS2G-1 $2,500,000; 4 killed

This Goodyear U. S. Navy Airship, designated the ZS2G–1, struck 45-foot-high trees while on a night flight, crashed and burned in a swamp. Of the seven crew members aboard the blimp, four were killed because of shock and burns and the three survivors all suffered major burns and cannot recall clearly the details of their escape. The fire reportedly started above the wheel well while the airship was still in flight but after it struck the trees. Apparently the impact with the trees ruptured the fuel cells (1,000 gallons of gasoline aboard) and the ignition source is indicated as arcing radar.

The accident was reported by phone within a few minutes from a residence

located about a mile from the crash scene. The owners of the home went to the scene but could not help the survivors without additional manpower. They thus returned home, alerted other residents and returned to the accident site. Improvised stretchers were made by these rescuers using pine saplings and pieces of the fabric from the unburned portions of the airship envelope. No fire equipment was available and the fire thus just burned out.

Feb. 20, San Francisco International Airport, South San Francisco, Calif., Pan American Airways, DC-7C $2,000,000

NFPA No. 403 covering Aircraft Rescue and Fire Fighting Services for Airports states "the off-road capability of vehicles designed for the service should weigh heavily in the selection of the vehicle purchased." This has been too often forgotten in designing these special vehicles.

At this accident, the crash equipment reached their original positions at the crash site successfully. The control tower had activated the airport crash alarm system, notifying the airport fire department that a DC-7 had crashed and was on fire at the end of Runway 28. The aircraft had only three crew members aboard.

The initial impact with the runway was apparently severe, perhaps caused by propeller malfunctioning during the descent. The left wing of the airplane, with its two engines, broke away from the fuselage at impact while the remaining portion of the aircraft bounced into the air, flew for about 100 feet and then hit the runway for a second time about 800 feet from the end of No. 28R. After this contact, it swerved to the left and skidded about 200 feet off the runway stopping almost in the center of a grass area between Runway 28R and a parallel runway.

The fire was instantaneous upon the first impact in the left wing, but observers did not see any fire in the main portion of the aircraft until it hit the runway for a second time. By the time it came to rest, the occupied portions of the fuselage, as well as the right wing, were so heavily involved in flames that arriving fire fighters could hardly see any portion of the plane.

Miraculously the three crew members escaped, one through a window on the left side of the cockpit and the other two through the pilot's door.

The first crash truck arrived in approximately two minutes. Informed en route that only the crew were aboard, fire fighrers concentrated their attack with low pressure carbon dioxide and foam on the cockpit and nose section. The results of this attack were good until the point where it was desirable to move the equipment closer to the fire, and then it was discovered that the heavy mud conditions and the limitations of the vehicles' traction and flotation prevented any movement of the trucks. Fire fighters continued to attempt extinguishment after having been informed that the personnel had all safely evacuated, and while control was established within about 30 minutes, complete extinguishment and overhaul required almost six hours.

Wide World

At San Francisco International Airport, this DC-7C burned to total destruction after a severe landing impact. Crash trucks had difficulty maneuvering at the off-the-runway site during the fire fighting effort handicapping effective control operations.

The airport fire department has available one low pressure carbon dioxide unit, two foam trucks, one dry chemical unit and one pumper. This city fire department-operated crash unit is backed up by additional fire equipment available from two airlines and the Coast Guard, each of whom have facilities at the airport. A total of ten officers and 48 fire fighters were thus available to service this emergency.

The problem of vehicle flotation and traction is further covered in a proposed NFPA Recommended Specifications and Performance Requirements for Aircraft Rescue and Fire Fighting Vehicles (NFPA No. 414-T) to be acted upon at the 1960 NFPA Annual Meeting.

Mar. 29, U. S. Naval Station, Argentia, Newfoundland, U. S. Navy WV-2 $2,250,000

Twenty-one crew members of this airborne radar picket aircraft escaped from the burning plane as it crash landed off the right side of the runway at this U. S. Naval Air Station. The first crash fire control units were on the scene within 60 seconds. The crash captain was informed immediately that all of the plane's crew members had escaped and fire fighters could thus concentrate on fire extinguishment. The crash captain spotted the six Navy crash trucks available in position to apply large volumes of foam on the fuselage and the surrounding area. The foam crash units included two MB-1's, two MB-2's, and two MB-5's manned by a total of 24 fire fighters (3 civilians and 21 military). They were backed up by crews manning three 750 gpm pumpers, a 2,000 gallon tank truck, and one aerial ladder from the Air Base structural fire department. These crews laid two 2½-inch hose lines from hydrants on the nearest hangar line.

Despite the massive foam attack which consumed 384 gallons of foam liquid concentrate it took 94 minutes to secure complete extinguishment using the combined efforts of the crash and structural fire departments. This shows the serious fire control problem presented by aircraft of this size following crash and the situation could have been worse had not the starboard wing plus No. 3 and 4 engines become detached from the fuselage during the deceleration with this detached portion of the wreckage coming to rest about 400 feet from the main wreckage. In addition to the foam attack from the turrets and hand lines of the crash truck, one of the 2½-inch hose lines was reduced to two 1½-inch lines which were used to cool the gasoline tanks of the WV-2 and extinguish flames in the fuselage. Five trimethoxyboroxine (TMB) extinguishers, seven 30-pound dry chemical extinguishers and eight 15-pound carbon dioxide extinguishers were also used in the attack.

The WV-2 (designated C-121 by the U. S. Air Force) is the U. S. Navy's radar picket plane and is a modification of the Constellation aircraft used in commercial transport operations. At the time of this accident the aircraft had about 4,000 gallons of fuel aboard (not a full load). The travel distance of the crash equipment was about ½ mile. The response was speeded by the immediate observation of the accident by the crash crews. The ground surface was asphalt. It was daylight. There was no rescue problem. The impact was "survivable" to all aboard. The weather was generally overcast, temperature: 24°; wind velocity: 32-41 knots; relative humidity: 96 per cent. In other words, at this accident a trained and amply equipped airport fire department was available, on the scene with a minimum of delay and yet the aircraft was a total loss as a result of the fire. This indicates one of two things: that extinguishment of fires of this type with present day mobile equipment is not feasible or that the equipment available or the training of the crash crews was not adequate in this particular case. There is no evidence to indicate the latter, but there is a long history of the former born of inadequate attention to the crash fire hazards of aircraft of this type (see also the following report of the accident of April 2).

Apr. 2, U. S. Naval Station, Argentia, Newfoundland, U. S. Navy WV-2 $2,250,000; 1 killed

A second WV-2 crash at the same Naval Station in the same week (as is reported in the previous analysis) resulted in another total aircraft loss and this time the death of one of the 24 crew members, minor burns to 7, and serious burns to 9.

In this case the aircraft crashed while attempting an emergency landing in a dense fog with its No. 4 engine feathered. Seconds after touchdown, it lost its starboard wing, somersaulted, and came to a stop on the right shoulder of the runway about 2,000 feet from the approach end. All except one of the air crew escaped unaided. The severed wing was left in the center of the runway about 150 feet from the burning fuselage.

Wide World

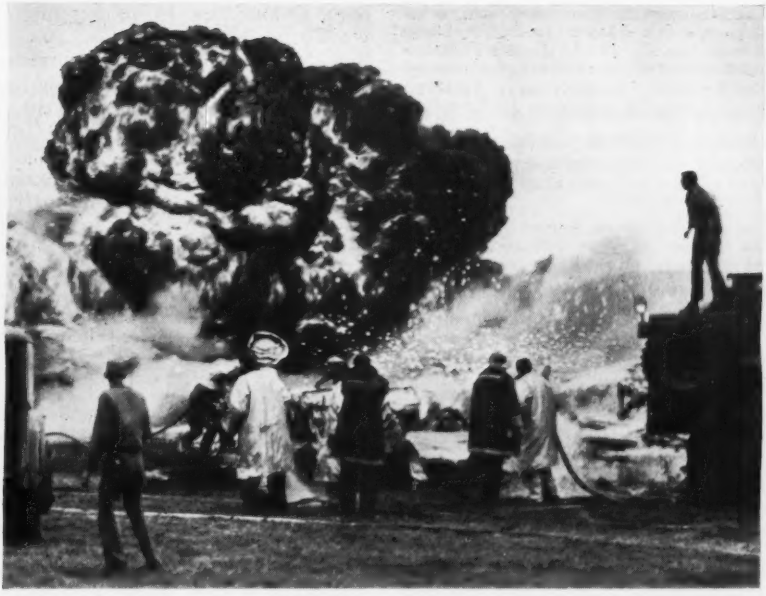
The arrow points to the runways at the Kanawha Airport, Charleston, W. Va., and the broken line to the route of the Constellation burning in the left foreground. Fire after crash barred escape for two of the 41 persons aboard.

Crash and structural fire fighting crews were on standby alert for this emergency landing and thus were able to respond immediately (distance: 1,000 feet, response time: 45 seconds). Again six crash trucks (two MB–1's, two MB–2's, and two MB–5's) were placed in service in a mass foam attack. Three structural fire companies likewise went into immediate action. One hydrant line (2½ inch) was laid 2,500 feet to supply a 2,000-gallon capacity tank truck which in turn replenished the crash trucks. Later this line was wyed to two 1½-inch lines, the latter then equipped with foam applicators, and both used as foam lines. Due to the intensity of the crash fire, it took the fire crews over an hour to bring the fire under control and final extinguishment was not secured until an hour and 15 minutes had passed. Twenty-four crash crew members were in action plus an unspecified number of structural fire department personnel who manned three 750 gpm pumpers, a 2,000 gallon tank truck and an aerial ladder. About 320 gallons of foam liquid concentrate was used in the attack. It is estimated that the aircraft had aboard 5,000 gallons of fuel at the time of the accident. The weather was foggy, humidity 94 per cent, temperature 33°F, wind, 2 knots. The time was 2335 to 0050.

Obviously, this accident had more complications than the earlier one. One man had been trapped inside the burning plane. The aircraft was inverted. It was foggy and dark. Again, however, the instant massiveness of the crash fire denied fire fighters the chance of rescue to say nothing of extinguishment. The charred body of the victim was found in the fuselage about mid-wing after the fire was extinguished.

May 12, Kanawha Airport, Charleston, W. Va., Capital Airlines, Constellation $1,000,000; 2 killed

A Capital Airlines Constellation with 41 persons aboard skidded off the runway and slid down an embankment and burned in a landing accident at this hilltop airport. Two



Wide World

During this crash fire at Lincoln Air Force Base, an explosion occurred which apparently was the result of an exploding tire and wheel assembly. Note the burning magnesium fragments which look like white specks against the billowing ball of fire.

passengers lost their lives and the aircraft was totally destroyed by fire. An NFPA technical committee member, en route to one of the Association's fire safety meetings, was aboard the aircraft when it crashed and was one of the 39 survivors to evacuate safely before flames barred the way.

Airport fire fighters were not effective in the emergency and the location of the accident site at the foot of the embankment handicapped accessibility. The airport's fire protection depended primarily on the Air National Guard which operated the only major crash trucks available. Insufficient hose even prevented effective use of hose streams on the burning aircraft. Only the tail section and parts of the wing extremities remained after the fire finally burned out.

The accident occurred on a wet runway, light rain falling at the time, and apparently was the result of an attempted turn off the runway at too high a ground speed. To occupants of the aircraft, it seemed as if the aircraft went over the embankment tail first. The deceleration was not severe, and fortunately the stewardess with the help of passengers was able to open the main cabin door which operates by sliding rearward. Most of the passengers made their escape through this door with the urging of the stewardess.

Later the same day, a Capital Airlines Viscount crashed near Baltimore, Maryland, with a loss of all 31 aboard. This second accident has been blamed by the CAB on "loss of control in extreme turbulence resulting in an involuntary steep descent following which aerodynamic loads from high airspeed, recovery and turbulence exceeded the design strength of the aircraft." While the Viscount fell to the ground in flames, it is not included in this analysis of large loss aircraft fires since the fire was incidental to the loss and not primarily responsible.

Oct. 8, Lincoln Air Force Base, Nebraska, U. S. Air Force, B–47E $3,500,000; 4 killed

A B–47E on take-off was sighted in distress by the relief crew of a Type 0–11A crash truck as it was being driven to the line standby position. The crew chief notified the crash operator by radio and responded to

the accident site immediately. One other 0–11A, an 0–11B, an 0–10, and an R–1 unit also were quickly at the scene which was about 200 feet off one of the major runways at the Air Base. In many ways, however, they might just as well have stayed in the fire house as the four members of the aircraft crew could not be reached due to the magnitude of the fire and smoke, and the aircraft was totally destroyed.

The six-jet-engined bomber with about 16,000 gallons of JP–4 fuel aboard broke apart at impact and the fire involved the entire wreckage in a cigar shaped area 1,000 feet long and 240 feet wide at its widest part. With an 18–28-knot gusty wind, a muddy terrain condition which handicapped vehicle movement, and difficulty with the turrets of both of the 0–11A's, the odds were heavily against a successful operation. The attack was with the wind with the major crash units concentrating on the nose section of the bomber containing the air crew members. The crash trucks were backed up by structural apparatus and personnel who laid 1,850 feet of 2½-inch hose lines which were subsequently wyed into two 1½-inch hose lines to replenish two of the operating crash trucks. In all 59 fire fighters (57 military and 2 civilian firemen) were on the scene and they used 820 gallons of foam liquid concentrate and 18,400 gallons of water in the fire extinguishment effort. The tragic accident occurred at 1136 and was not under control until 1210. The temperature was 46°F, the weather: partly cloudy.

Fires and Explosions in Flight

Nineteen of the large aircraft losses during 1959 resulted from fires in flight (12) or explosions while aloft (7). Two of these, one an uncontrolled fire and the second an alleged explosion, are reported in this summary analysis of the year, both involving civil aircraft. Information on military losses of this type has not been released to the NFPA in sufficient detail to permit intelligent analysis. During the year there were 7 military aircraft large loss flight fires and six military air-borne explosions, two of which were B–58 "Hustlers." There were also four other civil aircraft flight fires resulting in large losses (Mar. 30, near Alma, Ga., Riddle Airlines, C–46R; Oct. 19, near Arlington, Wash., Boeing Airplane Co., 707–227; Nov. 5, near St. Cleophas de Brandon, Quebec, Wheeler Airlines, DC–4; and Nov. 24, Chicago, Ill., Trans World Airlines, Constellation).

Two of the worst U. S. air disasters of 1959 are not included in this analysis. The accident of Mar. 12 involving a Capital Airlines Viscount was fatal to all 31 persons aboard but the fire followed disintegration in flight. On Nov. 16, 42 persons were killed when a National Airlines DC–7B crashed into the Gulf of Mexico without any hint of previous difficulty. In this latter case a strong suspicion exists that a bomb had been placed aboard the aircraft and detonated maliciously in flight. The investigation is continuing into this case but it is doubtful that proof will be possible because of the inability of salvage crews to raise the wreckage. A second bomb case occurring on Jan. 6, 1960, involving a National Airlines DC–6 has been linked with this mysterious case sufficiently to indicate some connection between the two.

Several very bad aircraft flight fires and explosions occurred in other parts of the world during 1959. Among the worst were the following:

June 26, Busto Arsizio, Italy, Trans World Airlines Constellation 1649–A; 69 killed

June 30, Ishikawa, Okinawa, U. S. Air Force, F–100; 21 killed, 100 injured (crashed into school building)

Sept. 30, Sao Paulo, Brazil, Viacao Aerea Sao Paulo transport aircraft; 20 killed

Sept. 24, Bordeaux, France, TAI Airlines DC–7; 53 killed

Oct. 29, near Athens, Greece, Olympic Airways transport aircraft; 18 killed

Jan. 17, Miami International Airport, Miami, Florida, Eastern Air Lines, Constellation 1049G $1,000,000

Fire in the No. 3 engine of this commercial transport followed engine failure immediately after take-off. The pilot executed

an emergency landing as the fire became uncontrollable despite discharge of the installed powerplant fire extinguishing system. After landing, the aircraft could be only partially braked and with the No. 3 and subsequently No. 4 engine inoperative, the reverse thrust of the props was not sufficiently effective to prevent the aircraft from overrunning the runway by about 75 feet. The main right landing gear collapsed as the aircraft came to a stop. At this time fire still poured from the No. 3 engine and was gaining in intensity.

Stewardesses had prepared for cabin evacuation of the light passenger load aboard (12 persons), and the emergency slide chute from the main cabin door was used to evacuate all but two of the passengers and the 5 crew members. Two male passengers left the cabin through a window exit and then held the bottom of the emergency chute for the others to slide down. The aircraft captain was the last to depart, and while no accurate evacuation time is available, it was agreed that the entire evacuation was accomplished in not much more than a minute.

The in-flight fire was apparently the result of a failure of a connecting rod in the No. 3 engine leading to progressive damage in the engine. An abnormal exhaust flame thus caused is believed to have ignited a flammable fuel vapor-air mixture discharging from the outboard breather port of the engine. From here the flames penetrated the aluminum wheel well doors resulting in a fire in this section of the nacelle which is not protected by either a fire detection or extinguishing system. Thus, when the power-plant fire extinguishing system was activated, the agent (dibromodifluoromethane) discharged normally but had no chance to halt the spreading flames in the unprotected wheel well.

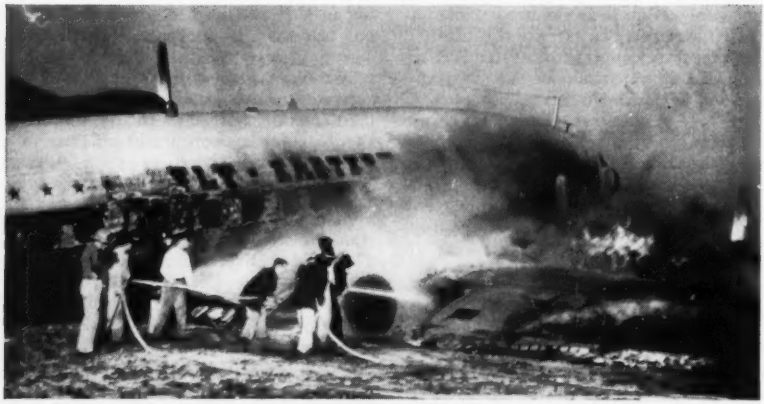
The Airport Fire Department had been alerted by the Control Tower and were standing by for the emergency landing. They had available 3 foam trucks (one 1,000-gallon-capacity unit, a USAF Type 0–10, and a 500-gallon-capacity truck) plus one pumper. The CAB report (File No. 1–0024) on the accident treats the fire fighting activity in the following manner:

"From competent witnesses of the Airport Fire Department it was learned that foam was used as the principal extinguishing agent, and the total capacity of the four pieces of equipment manned at the accident was about 2,150 gallons of water-foam mixed in a 10 to 1 ratio. This total capacity could be discharged in about five minutes. Additional foam concentrate was not carried to the accident scene and other than hand extinguishers, the department had no extinguishing agent to supplement the foam. Water, however, was available to any part of the airport through a system of wells and hydrants.

"Compared to NFPA (National Fire Protection Association) suggestions, which, in

Wide World

An airborne engine fire aboard this Constellation became uncontrollable after it entered the wheel well. After this emergency landing, the aircraft continued to burn (see photo next page).



Wide World

"The amount of foam available was well below the amount suggested" by NFPA. This estimate was reported by the CAB in their official report and was believed responsible for the extent of the damage resulting.

this field, are widely accepted in the absence of any regulatory matter, the amount of foam available at the scene was well below the amount suggested. As indicated, the suggested amount of supplementary extinguishing agent, such as dry chemical or carbon dioxide, was not possessed. The discharge rate capacity of the equipment was about one-half that of the NFPA suggested rate. In addition, the Port Authority lacked such important rescue equipment as power saws and escape stairs.

"During the investigation comparisons were also made between the Miami International Airport rescue and fire fighting equipment and equipment capabilities and those of other airports of similar size and generating comparable traffic factors. The comparison showed Miami far below New York, Los Angeles, San Francisco, and Chicago.

"The equipment reached the aircraft before it stopped and the prime piece of equipment was positioned at the cabin door to carry out the first and all important mission of protecting and assisting the evacuating occupants. When this was assured, the equipment was moved in front of the burning wing, close to the fuselage. Another foam truck was positioned behind the wing and at the same time hose lines were laid to water sources. Both foam trucks laid foam on the fire according to accepted techniques. According to nearly all observers, in a few minutes the fire, then being fed by about 1,700 gallons of fuel from the right wing fuel cells, was under control and nearly out. At this time the foam supply at the scene was exhausted. Two flashbacks of the fire then occurred and it rekindled to its original intensity. The lieutenant in charge of the airport equipment at the scene stated, in essence, that when the fire was nearly out and despite the flashbacks only a small amount of additional foam would have enabled his personnel to have put out the fire. Without it, extinguishment took the combined efforts of his equipment and the off-airport equipment that reached the scene about the time the fire rekindled. The fire was finally extinguished by using several thousand gallons of water. The evidence indicates that the difficulty encountered in extinguishing the fire was caused by the lack of equipment rather than improper fire fighting techniques and tactics."

As a footnote to this accident an FAA Airworthiness Directive was issued on March 7, 1960 (No. 60-5), to apply to all Lockheed Models 1049C, D, E, G, and H airplanes calling for either: (1) replacement of the aluminum skin on the forward landing gear doors with "fireproof" material, (2) covering the present aluminum doors with "fireproof" material, or (3) coating both inside and outside of the present aluminum doors with a material (specified in the Directive) that will withstand a flame of 2,000°F for 15 minutes. In addition, the Directive required installing "fire sleeves"

over all flammable fluid-carrying flexible hose lines in Zone 3 (engine accessory section) and 3A (wheel well) in the inboard engine nacelles of this aircraft.

As a second footnote to this accident, the Dade County Port Authority has advised the NFPA as of February 1960 that they had purchased and received delivery of a 700 pound dry chemical truck and had on order a major new foam unit plus a 2,000 gallon "nurse" (tank) truck to improve the crash protection at Miami International Airport.

Sept. 29, near Buffalo, Texas, Braniff Airways, Electra $2,300,000; 34 killed

A great deal of mystery still surrounds this largest loss-of-life aircraft accident included in this year's list of large loss aircraft fire disasters.* About all that is known is that the aircraft exploded or disintegrated in flight. Fire may have occurred instantaneously with the explosion or disintegration or immediately thereafter. It was observed burning in its descent from 15,000 feet. The main portion of the fuselage followed the flight trajectory after losing both its wings in flight. Ground wreckage was scattered along the flight path with pieces found as far as 13,900 feet from the site of the main wreckage. The left wing apparently failed first and there was evidence of fire on the left wing inboard portion. There was heat damage to the fuselage windows on the left side rear of the trailing edge and there was smoking of even the rear left fuselage. All 34 aboard were killed.

Another in-flight explosion or disintegration, fatal to all 63 occupants, occurred to a Northwest Airlines Electra near Tell City, Indiana, on March 17, 1960. Following this accident, likewise still being investigated, airborne cruising speed restrictions were imposed on the aircraft with the theory that the explosions or disintegrations in both cases may have been caused by air turbulence or some structural weakness in the airframe. Lockheed, the FAA, and the NASA are conducting a series of intensive flight and static test programs on the turboprop aircraft.

Aircraft-Missile Ground Fires

The largest fire loss of the year was an aircraft fire on the ground. This occurred at Carswell Air Force Base, Texas, on September 16 and involved a B–58 for which a loss figure of $24,000,000 has been established. Two crewmen died and the pilot was injured. Apparently occurring during a take-off run but while still on the ground, the Delta wing bomber burned for more than an hour despite the availability of a well trained and equipped Air Base fire department. Efforts to get further details have been unavailing, presumably because of military security.

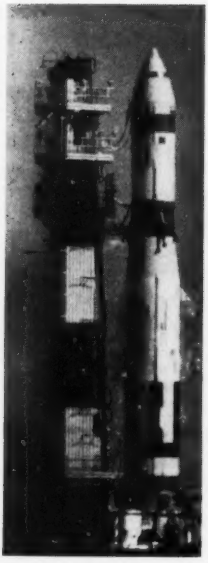
One of the other six aircraft ground fires involved another B–58 which burned on the ramp at the Convair plant in Fort Worth while the aircraft was undergoing maintenance. One workman was killed and the loss set at $10,000,000. Two other large loss aircraft ground fires occurred at USAF Air Bases due to maintenance errors, one involving a KC–97 tanker plane and the second a KC–135. Aboard the USS *Wasp*, a hangar deck fire occurred which caused $3,000,000 damage to 4 helicopters. The other two ground fires are reported in this summary analysis.

July 14, Wold-Chamberlain Airport, Minneapolis-St. Paul, Minn., Northwest Airlines, Boeing Stratocruiser $1,500,000

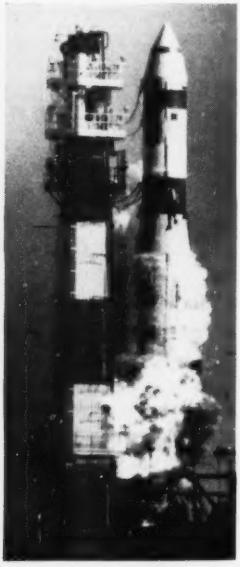
This Stratocruiser burned while parked at a passenger loading gate at the Airport. A preflight check was being made by the flight engineer. He turned on the aircraft oxygen system and a fire started immediately thereafter behind the coatroom in the fuselage. Investigation indicated that an oxygen valve located in this area sustained a fatigue failure. The escaping oxygen impinged directly on glass wool insulation in the area resulting in the ignition of the resin binding of the insulation. It was not possible to shut off the oxygen supply so that the fire was accelerated by the addition of the gaseous oxygen in the fire area for a period of about 14 minutes.

The fire was discovered immediately by employees in the area and several airline employees made brave attempts to fight the fire from the interior of the aircraft but could

*There were a number of other major U. S. aircraft accidents with larger loss of life, but fire was either not involved or was not considered responsible for the loss in these other cases.



Sequence Photo 1.



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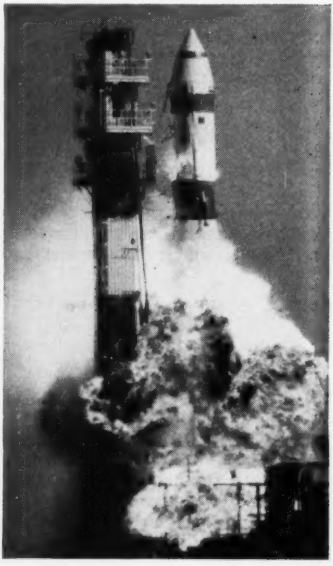

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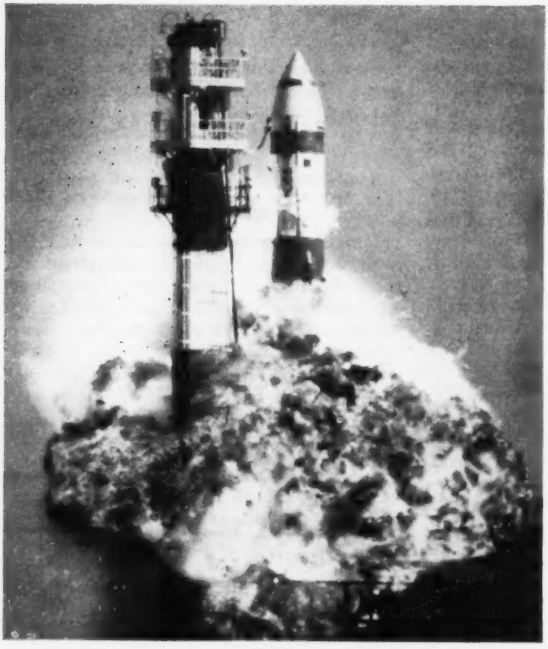

Sequence Photo 4.

These official U. S. Air Force photos show the loss of a Titan C-3 Intercontinental Ballistic Missile at Cape Canaveral, Florida, on Dec. 12. The loss was believed caused by the unintentional mechanical closing of an electrical relay in the safety destruct system. Note how the missile gradually sinks toward the pad as the fire gains in intensity.

Sequence Photo 5.

not do so successfully with portable fire extinguishers. The oxygen cylinder was located in the rear of the coatroom with the valve directly behind the coatroom lining imbedded in the glass insulation. As the oxygen enriched flames spread to the other portions of the fuselage interior, heat and smoke forced evacuation of the aircraft.

Airport fire fighters responded to the fire site immediately. Five City Fire Department engine companies, a ladder company, and a rescue squad were called to the scene along with equipment from the U. S. Air Force. The initial fire fighting attack was with a bayonet foam nozzle. This was followed by the use of two 1½-inch water fog lines brought into the fuselage by fire fighters. Before extinguishment could be secured, major damage had been caused, and judging from the size of the loss figure, it appears that the aircraft has been written off as a total loss.

Dec. 12, Cape Canaveral, Florida, U. S. Air Force Titan C–3 ICBM $2,000,000

Believed caused by the unintentional mechanical closing of an electrical relay in the safety destruct system, a USAF–Martin Titan C–3 intercontinental ballistic missile was destroyed by fire on its launching pad at the Air Force's Missile Test Center at Cape Canaveral at 12:11 p.m. on Dec. 12. Many other missiles have exploded and burned during the missile test programs in operation at various U. S. test centers. In all other previous cases, however, the explosions have apparently occurred after "blast-off." Such losses have not been included in the NFPA large loss fire records since the missiles would have been destroyed even if the launchings had been successful, that result being inherent in the operations.

In this case, the 110 ton ICBM was destroyed on the pad before "blast-off" after the liquid oxygen and the propellants used were released following rupture of the liquid oxygen and fuel tanks by the primacord in the destruct system. Normally such destruction would occur only when activated by radio after the missile is in flight and the decision had been made to destroy the vehicle because of improper or erratic flight. Extensive damage in this ground accident was also caused to the electrical lines, hydraulic lines, and other components of the launching pad. Full data on the extent of the loss to the ground installations is not available and the loss figure given above is an estimate for the ICBM only.

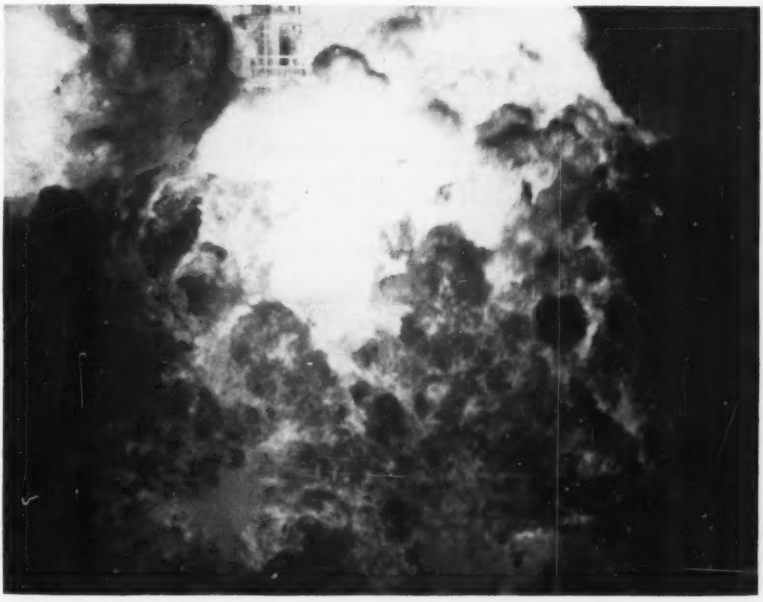

Table II

List of 1959 Large Loss Fires By Occupancies

NOTE: See Index to Volume 53 for page references to reports on fires included in this and other issues of the QUARTERLY in this volume.

Asterisk (*) Before Date Indicates Fire Spread to Other Buildings

The Large Industrial Fires of 1959

	Total No. of Fires	Total No. Killed	Total No. Injured	Total Property Damage Loss	Total Insured Indirect Loss
U. S. Losses	102	21	196	$52,510.0	$5,192.0
Canadian Losses	11	1	1	5,894.5	408.5
Total Losses	113	22	197	$58,404.5	$5,600.5

Date	Place and Occupant	No. Dead	No. Injured	Property Damage In Thousands	Insured Indirect Loss
	Boat Manufacturing				
Jul. 11	near Grants, N.Mex., Continental Boat Co., et al.	..	..	$325.0	..
	Brick & Tile Plants				
Apr. 1	Mount Braddock, Pa., Eureka Fire-Brick Works	..	..	300.0	..
*Sep. 12	Uhrichsville, Ohio, Stillwater Clay Products Co.	..	1	645.0	Yes
Nov. 2	Birmingham, Ala., W. D. Dickey Clay Mfg. Co.	..	..	800.0	$500.0
	Carbon Works				
Jan. 30	near Marshall, Tex., Atlas Powder Co.	..	..	338.5	6.5
	Chemical Plants				
Jan. 8	Reading, Pa., Belle Chemical Co.	..	1	400.0	..
*Jan. 30	near Follansbee, W.Va., Koppers Co., Inc.	..	2	871.5	309.5
Mar. 5	Van Nuys, Calif., Riders, Ltd.	..	..	305.0	..
*Apr. 23	Kansas City, Kans., Thompson-Hayward Chemical Co.	3	10	653.0	100.0
May 11	Maysville, Ky., Ohio Valley Fertilizer Co.	..	..	313.5	..
Jul. 5	Acton, Mass., Dewey & Almy Chemical Division	..	9	300.0	..
Jul. 22	Niagara Falls, N.Y., Hooker Chemical Corp.	1	2	325.0	..
	Electric Generating Plants				
Apr. 1	Woodland, Maine, St. Croix Paper Co.	..	2	375.0	..
Nov. 24	Vestaburg, Mich., Wolverine Electric — Branch of R.E.A.	1	2	300.0	..
	Food and Food Products				
	Breweries				
Dec. 12	La Crosse, Wis., G. Heileman Brewing Co.	..	1	302.0	2.5
	Candy Factories				
Sep. 5	Beloit, Wis., Korn Kurl, Div. of Adams Corp.	..	1	463.0	..
	Canneries				
*Jan. 20	Sunnyvale, Calif., Libby, McNeill & Libby	..	3	605.0	..
Jul. 23	Milton — Freewater, Oreg., Rogers Canning Co.	..	..	428.0	..
Oct. 17	Fremont, Calif., F. E. Booth Co., Inc.	..	3	2,350.0	250.0
	Dairy Products				
May 23	Chicago, Ill., Brook Hill Farms, Inc., et al.	..	5	350.0	..

Table II — Continued

Date	Place and Occupant	No. Dead	No. Injured	Property Damage in Thousands	Insured Indirect Loss
Flour and Feed Mills					
Feb. 8	Homer, N.Y., Homer H. Jones Feed Mill	..	..	$300.0	..
*Mar. 17	Newton, Kans., The Consolidated Flour Mills Co.	..	..	293.0	..
Jul. 10	Lexington, Ky., Woolcott Mills, Inc.	..	3	250.0	..
Dec. 31	Colby, Wis., Colby Milling, Inc.	2	3	253.5	
Fruit Packing					
*Jan. 6	Montalvo, Calif., Ventura Processors	..	6	690.0	$115.5
Jun. 10	Oroville, Wash., Oroville Warehouse Co.	..	..	626.0	Yes
*Jul. 5	Tonasket, Wash., Tonasket United Growers, Inc., et al	..	1	675.0	Yes
Aug. 19	Leavenworth, Wash., Leavenworth Fruit Co.	..	2	270.0	..
Sep. 28	near Tonasket, Wash., Ellisforde Independent Growers, Inc.	..	..	300.0	..
*Nov. 10	Soquel, Calif., United Frozen Foods, et al	..	..	296.5	..
Nov. 26	Modesto, Calif., Boothe Fruit Co.	..	1	562.0	..
Packing Houses					
Jan. 29	North Sydney, N.S., Leonard Bros., Div. of National Sea Products, Ltd.	1	..	493.5	..
Feb. 24	Yarrow, B.C., Cascade Foods Ltd.	..	..	350.0	..
Mar. 5	San Francisco, Calif., J. G. Johnson Meat Co.	..	5	250.0	..
Mar. 19	near Chico, Calif., Continental Nut Co.	..	1	340.5	..
Rice Mills					
Jul. 14	Richmond, B.C., Canadian Rice Mills, Ltd., et al	..	..	449.0	408.5
Sugar					
Mar. 3	Patoutville, La., Enterprise Sugar House, et al	..	1	537.0	..
	Gas Manufacturing				
*Dec. 25	East Chicago, Ind., Linde Air Products, Div. of Union Carbide & Carbon Corp.	1	..	250.0	..
	Glass Works				
Jun. 8	Uniondale, N.Y., Camac Applied Labeling Corp.	..	..	297.0	..
	Leather Working				
Feb. 3	Frankford, Ont., Bata Shoe Co.	..	..	583.0	..
	Mattress Plant				
*Jan. 31	Medford, Mass., Lindner Mattress Co., et al	..	5	250.0	..
	Metalworking				
Aircraft Assembling					
May 20	Middle River, Md., Martin Co.	5	5	630.0	..
Copper, Tin, Zinc Fabricating					
Jan. 23	Danbury, Conn., Perkins-Elmer Machine Co.	..	..	250.0	..
Nov. 1	Blissfield, Mich., Blissfield Manufacturing Co.	..	2	850.0	..

Table II — Continued

Date	Place and Occupant	No. Dead	No. Injured	Property Damage In Thousands	Insured Indirect Loss
Electrical Appliances, Equipment					
Jun. 10	Paterson, N.J., General Electronics, Inc.	..	..	$500.0	..
Aug. 11	Glendora, Calif., Conrac, Inc.	..	1	424.0	$12.0
Oct. 22	Brooklyn, N.Y., Eastern Precision Resistor Corp., et al	..	..	375.0	..
Dec. 7	Los Angeles, Calif., Stepper Motors, Div. of Land-Air, Inc.	..	..	466.0	..
Foundries					
Feb. 4	Richmond, Va., Richmond Foundry & Mfg. Co.	..	..	375.0	33.0
Feb. 6	Erie, Pa., Cascade Foundry Co.	..	5	750.0	..
Feb. 7	Ellwood City, Pa., National Plumbing & Fixture Co.	..	1	294.0	Yes
Iron Conversion					
Jan. 14	Trenton, Mich., McLouth Steel Corp.	..	..	250.0	150.0
Jun. 25	River Rouge, Mich., National Steel Corp.	..	..	290.0	..
Sep. 30	Hamilton, Ont., Dominion Foundries & Steel Company Ltd.	..	..	300.0	Yes
Magnesium Fabrication					
Aug. 25	Deerfield, Ill., Kleinschmidt, Div. of Smith Corona Marchant, Inc.	..	..	400.0	450.0
Repair Shops					
May 20	N. Little Rock, Ark., Missouri Pacific Railroad	..	..	250.0	..
Steel Fabrication					
Jan. 1	Grayslake, Ill., Burgess Vibrocrafters, Inc.	..	..	710.0	445.0
Jan. 31	Northfield Twp., Ill., Gerbing Mfg. Co.	..	..	300.0	110.0
Feb. 14	Salt Lake City, Utah, Lang Co., Div., of Union Tank Car Co.	..	..	515.0	30.0
Feb. 18	Latrobe, Pa., Alco Products Co., Inc.	..	2	900.0	Yes
Mar. 24	Newark, N.J., Kingsland Drum & Barrel Co.	..	..	415.0	..
Apr. 5	W. Bloomfield Twp., Mich., Stainless Ware Co. of America	..	..	2,000.0	100.0
Apr. 21	Richmond, Va., Recony Corp.	..	..	1,460.0	..
May 9	E. Greenwich, R.I., Efco Mfg. Co., et al	..	4	275.0	
May 21	Connellsville, Pa., Connellsville Mfg. & Mine Supply Co.	..	2	563.0	..
Jun. 29	Riverdale, Ga., Carlson Industries & Tu-Tone Corp.	..	..	450.0	..
*Aug. 2	Garwood, N.J., New Jersey Foundry & Machine Co., et al	..	4	250.0	50.0
Dec. 9	near Wayne, Pa., Wayne Iron Works	..	..	1,000.0	..
Mining					
Jan. 6	Roche Percee, Sask., Old Mac Coal, Ltd.	..	..	392.0	..
Apr. 25	Domino, Ky., Sunfire Coal Co.	..	..	255.0	..
*May 23	Tioga, Nicholas County, W.Va., Tioga Coal Corp.	..	..	250.0	..
Multiple Occupancy Manufacturing					
May 9	Philadelphia, Pa., Fretz Building	..	..	300.0	Yes
Paper Working					
Aug. 2	Desbiens, P.Q., St. Raymond Paper Co., Ltd.	..	..	679.5	..
Sep. 1	Wellsville, Pa., Shenandoah Floral Mfg. Co.	..	2	250.0	..
Sep. 14	Evandale, Tex., East Texas Pulp & Paper Co.	5	11	1,750.0	600.0
Sep. 27	Chicago, Ill., Union Bag and Paper Corp.	..	..	301.0	20.0
Plastic Working					
Feb. 3	St. Louis, Mo., F. Burkart Mfg. Co., Div. of Textron, Inc.	..	..	250.0	25.0
Jun. 9	Nitro, W.Va., Ohio-Apex, Div. of Food Machinery Corp.	..	2	867.0	244.0

Table II — Continued

Date	Place and Occupant	No. Dead	No. Injured	Property Damage In Thousands	Insured Indirect Loss
	Printing Plants				
Jun. 6	near Freeburg, Ill., Donley Company	..	2	$250.0	..
Feb. 5	Ada, Okla., Ada Evening News	..	..	250.0	..
	Refineries				
	Animal				
Apr. 17	Reading, Ohio, Darling and Co.	..	..	500.0	..
	Petroleum				
*Jan. 22	Ponca City, Okla., Cities Service Oil Co.	1	1	400.0	..
*Aug. 24	Oklahoma City, Okla., Cato Oil & Grease Co.	..	13	1,052.0	..
Dec. 5	Lockport, Ill., Texaco, Inc.	..	..	270.0	..
	Rubber Works				
May 20	Houston, Tex., Perlfoam	..	12	295.0	$250.0
May 26	near Houston, Tex., Foam Rubber & Fabric Distributors, Inc.	..	..	250.0	..
	Soap Works				
*Jun. 10	near E. Joliet, Ill., Ultra Chemical Co., et al.	..	2	400.0	100.0
	Textile Working				
Jan. 6	W. Frankfort, Ill., Streamline Garment Corp.	..	..	393.0	..
*Jan. 26	Seneca Falls, N.Y., Seneca Knitting Mills, Inc.	..	1	1,995.5	502.0
Feb. 25	Scottsville, Ky., Washington Overall Mfg. Co., Inc.	..	..	350.0	..
Apr. 6	near Lincolnton, N.C., Long Shoals Cotton Mills, Inc.	..	..	600.0	..
Apr. 10	Willimantic, Conn., American Thread Co.	..	..	253.0	125.0
Jun. 29	Los Angeles, Calif., Terry Tuck, Inc.	..	2	260.0	30.0
Oct. 13	near Williamsport, Md., Federal Silk Mills, Inc., et al.	..	..	1,250.0	..
	Woodworking				
	Building Supplies				
*Mar. 19	near Phoenix, Ariz., Silvey Products, Inc.	..	2	516.0	..
*Jun. 12	Sweet Home, Oreg., Oregon Plywood Corp.	..	..	538.0	..
*Jul. 16	South Nelson, N.B., O'Brien's Mill	..	..	422.5	..
*Jul. 26	Eugene, Oreg., Campbell-McLean Plywood, Inc.	..	1	730.0	..
*Aug. 6	Albany, Oreg., Linn Plywood Corp.	..	..	1,423.0	173.0
*Aug. 14	Juneau, Alaska, Alaska Plywood Corp., et al.	..	..	580.0	..
Nov. 11	Weatherly, Pa., Rad Woodwork Co., Inc.	1	5	300.0	..
Nov. 15	Dallas, Tex., Clem Lumber Co.	..	2	250.0	..
	Furniture Factories				
Mar. 3	Philadelphia, Pa., Cambridge Mfg. Co., Inc.	..	..	250.0	..
*Apr. 27	Ste. Therese, P.Q., Dominion Furniture Mfgrs., Ltd.	..	..	736.5	..
*May 9	Tacoma, Wash., Bartron Co., et al.	..	39	356.0	..
	Saw and Planing Mills				
*May 23	near Jasper, Tex., Angelina County Lumber Co.	..	..	331.0	..
Jul. 16	Century, Fla., Alger-Sullivan Saw Mill Co.	..	..	460.5	300.0
Nov. 5	Tillamook, Oreg., Buehner Lumber Co.	..	..	271.0	159.0
	Wood Products				
Jan. 16	near St. John's, N.F., Newfoundland Atlantic Hardboards Industries, Ltd.	..	..	750.0	..
Apr. 18	Calais, Maine, Northeast Industries	..	..	250.0	..
*Jun. 15	Lanark, Ont., Campbell Sash & Door Factory, et al.	..	1	738.5	..
Nov. 24	Washington Court House, Ohio, Weber C. French Mfg. Co.	1	3	300.0	..
Dec. 29	Milpitas, Calif., Flush Panel Corp.	..	..	481.0	..

Table II — Continued

The Large Mercantile Fires of 1959

	Total No. of Fires	Total No. Killed	Total No. Injured	Total Property Damage Loss	Total Insured Indirect Loss
U. S. Losses	82	4	315	$34,953.0	$1,337.0
Canadian Losses	7	2	9	3,667.5	0.0
Total Losses	89	6	324	$38,620.5	$1,337.0

Date	Place and Occupant	No. Dead	No. Injured	Property Damage In Thousands	Insured Indirect Loss
	Automobile Salesrooms				
Jan. 21	Nampa, Idaho, Showalter Chevrolet Co.	..	..	$250.0	Yes
*Apr. 15	Paducah, Ky., B. F. Goodrich Co.	..	..	351.0	..
	Dry Goods Stores				
Jan. 5	Niagara Falls, N.Y., Gluck Building	..	10	813.0	..
*Jan. 6	Paterson, N.J., Kortch's Clothing, et al	..	6	1,000.0	..
Jan. 8	Buffalo, N.Y., 3101 Realty Corp.	..	6	250.0	..
Jan. 15	Detroit, Mich., Morey Scholnick Clothing Store	..	..	273.5	..
Jan. 20	Salina, Kans., J. C. Penney Store	..	4	305.0	..
Jan. 22	Michigan City, Ind., Edwards Store for Men	1	7	393.0	..
*Mar. 21	Bayonne, N.J., Mademoiselle Shop, et al	..	..	450.0	..
*Apr. 22	Houghton, Mich., Seaman Building, et al	..	..	325.0	..
Sep. 14	Kalispell, Mont., Conrad Bank Bldg.	..	2	1,376.0	$124.0
Nov. 16	Staten Island, N.Y., Ropley Mfg. Co., et al	1	9	270.0	..
	Department Stores				
*Jan. 9	Forrest City, Ark., Cohen's Department Store, et al	..	1	308.0	20.0
Mar. 5	Jersey City, N.J., N.J. Warehouse Distributing Corp.	..	2	592.5	254.5
*Apr. 26	Midland, Mich., Sears Roebuck, et al.	..	3	813.5	..
May 6	Abilene, Tex., Thornton's Department Store	..	..	1,311.0	..
May 20	Paris, Tex., Ayers Dept. Store, et al	..	4	279.0	45.0
Jun. 27	Darby, Pa., Wellworth Department Store	..	26	425.0	..
Jul. 17	Vancouver, B.C., Wosk's Limited	..	2	347.0	..
*Jul. 19	Warren, Mich., Hall's Department Store	..	3	715.0	..
Nov. 15	Stratford, Wis., Davel Bros. and Zoellner	..	..	333.0	..
Nov. 21	Ansonia, Conn., Smith Building	..	5	350.0	..
*Dec. 23	Abbeville, S.C., Belk-Simpson Co., et al	..	2	500.0	..
	Five Cent to a Dollar Stores				
Jan. 28	Gainesville, Ga., Clary's 5 & 10	..	1	250.0	..
Mar. 27	Millburn, N.J., F. W.Woolworth, et al	..	9	350.0	..
Mar. 28	Paris, Tex., S. H. Kress & Co.	..	3	445.5	..
*Aug. 1	Marinette, Wis., McCrory-McLellan Stores, et al	..	5	290.5	14.0
Sep. 5	Flint, Mich., S. S. Kresge & Co.	..	30	548.0	..
*Sep. 19	Fairbanks, Alaska, Thriftway Variety Store	..	2	250.0	..
Dec. 27	Lewisburg, Pa., J. J. Newberry Co.	..	..	360.5	..
	Furniture Stores				
Jan. 30	Connellsville, Pa., Sam Levin Furniture Co.	..	9	250.0	..
Feb. 26	Oakville, Ont., Trafalgar Building	..	..	619.5	..
*Mar. 6	Sorel, P.Q., A. Cournoyer & Sons, et al	..	2	307.5	..
Jun. 12	San Francisco, Calif., Sterling Furniture Co.	..	1	271.5	239.0
Sep. 8	Honolulu, Hawaii, Van's Furniture Store	..	..	400.0	25.0
Dec. 12	Youngstown, Ohio, Humes Furniture Co.	..	..	470.0	Yes
	Grocery Stores				
*Jan. 16	Bucksport, Maine, Alton Grindle Grocery Store, et al	1	..	400.0	..
*Feb. 12	Heber Springs, Ark., Stair Produce Co., et al.	..	..	300.0	..
*Oct. 11	Sisseton, S.Dak., Red Owl Grocery	..	1	370.5	..

Table II — Continued

Date	Place and Occupant	No. Dead	No. Injured	Property Damage In Thousands	Insured Indirect Loss In Thousands
	Hardware Stores				
Jan. 15	New York, N.Y., Vim Radio, et al.	..	5	$725.0	..
Feb. 9	York, Pa., Miller's of York, Inc.	..	5	275.0	..
Jun. 11	near Englishtown, N.J., Englishtown Auction Sales, Inc.	..	6	500.0	..
Aug. 10	Scranton, Pa., K & K Auto Parts Co.	..	8	320.0	..
*Aug. 13	Pontotoc, Miss., Bigham-Anderson Hardware Co., et al.	..	..	250.0	..
Aug. 17	San Luis Obispo, Calif., Standard Auto Parts Store, et al.	..	..	250.0	..
Oct. 16	Portland, Tenn., J. E. Kerley & Sons, et al	..	..	294.0	..
Nov. 14	Rockaway, N.J., Rockaway Sales Co.	..	13	550.0	..
Dec. 1	Evansville, Ind., Red Spot Paint & Varnish Co.	..	2	826.5	$120.0
	Multiple Occupancy Stores				
Jan. 18	Philadelphia, Pa., Kensington Farmers Market	..	2	250.0	..
Feb. 5	Copiague, N.Y., Amityville Farmers Market	..	..	500.0	..
Apr. 5	Windsor, Ont., La Belle Building	..	1	640.0	..
Apr. 25	Kansas City, Mo., Bradford Building	..	..	250.0	..
Apr. 26	Bristol Twp., Pa., Seymour's Surplus Store, et al.	..	19	300.0	..
*Apr. 27	Plattsburg, N.Y., Meyer's Drug Store, et al.	..	5	286.0	..
Jun. 11	Jacksonville, Fla., U.S. Naval Air Station	..	3	328.0	..
Jul. 6	East Chicago, Ind., Riley Building.	..	6	375.5	20.0
Jul. 6	Ottawa, Ill., Colwell Bldg., et al	..	2	312.0	20.0
*Jul. 14	Nashua, N.H., Nutt Bldg. et al.	..	13	393.5	35.5
Dec. 10	Indianapolis, Ind., Haag Drug Co., Inc.	..	..	335.0	15.0
Dec. 24	Horsham Twp., Pa., Bargain City, U.S.A.	..	..	1,100.0	Yes
	Restaurants				
*Jan. 20	Sioux City, Iowa, John's Cafe	..	..	606.0	29.0
Jan. 21	New York, N.Y., Artel Foods, Inc., et al	..	4	306.5	..
*Feb. 9	Monticello, N.Y., Oriental Restaurant	..	4	300.0	..
*Feb. 23	Montreal, P.Q., American Spaghetti House, et al.	2	2	496.0	..
Apr. 26	Baltimore, Md., Mandell & Ballow, et al.	..	..	411.0	42.5
May 24	Klamath Falls, Oreg., Maguire Building	..	3	347.0	60.0
*Jul. 12	Williston, N.Dak., Ditsworth Charcoal Grill, et al.	..	..	345.0	..
Jul. 13	Cedar Rapids, Iowa, Town House Motel	..	..	261.0	..
*Jul. 17	Shelby, Mont., Mint Cafe, et al.	..	1	300.0	..
Aug. 14	Erlanger, Ky., Greater Cincinnati Airport	1	17	600.0	..
	Shoe Stores				
*Jun. 24	Darby, Pa., Roberts Shoe Store, et al.	..	2	270.0	..
Nov. 18	Mt. Clemens, Mich., Nunneley Shoe Store, et al.	..	2	250.0	..
Nov. 28	Brunswick, Ga., Novelty Shoe Store	..	1	250.0	..
	Shopping Centers				
Jan. 24	Glendale, Wis., Bayshore Center	..	1	423.5	25.0
Jul. 3	St. Petersburg, Fla., McCroy's Inc.	..	5	404.5	..
	Supermarkets				
Feb. 8	Fort Garry, Man., Loblaw's Supermarket	..	..	287.5	..
Feb. 28	Farmington, Mich., National Food Stores	..	1	250.0	..
Apr. 20	Walla Walla, Wash., Albertson's Food Market	..	2	368.5	80.0
Jul. 22	Salt Lake City, Utah, Grand Central Market	..	2	626.0	129.5
Sep. 27	Pontiac, Mich., Kroger Company	..	1	250.0	..
Nov. 16	Atchison, Kans., Safeway Stores	..	..	250.0	..
*Dec. 16	Kitchener, Ont., Loblaw Grocery Store, et al.	..	2	970.0	..
Dec. 17	Tacoma, Wash., Safeway Stores	..	2	429.0	..
Dec. 20	Beaver Falls, Pa., Great Atlantic and Pacific Tea Co.	..	6	432.0	..
	Wholesale Stores				
Jan. 19	Milwaukee, Wis., Wisconsin DeLuxe Co.	..	2	275.0	..
Mar. 4	Superior, Wis., Central Co-op Co.	..	6	310.0	..
Mar. 5	Winston-Salem, N.C., Curb Market	..	1	250.0	..
Apr. 25	Lincoln, Nebr., Donley Medical Supply Co., et al.	..	6	369.5	..
Sep. 26	Kansas City, Mo., Abills Distributing Co.	..	6	270.0	39.0

Table II — Continued

The Large Storage Fires of 1959

	Total No. of Fires	Total No. Killed	Total No. Injured	Total Property Damage Loss	Total Insured Indirect Loss
U. S. Losses	41	15	239	$30,098.5	$404.5
Canadian Losses	13	0	16	10,380.0	0.0
Total Losses	54	15	255	$40,478.5	$404.5

Date	Place and Occupant	No. Dead	No. Injured	Property Damage In Thousands	Insured Indirect Loss
	Building Material Warehouses				
Jul. 27	Taunton, Mass., L. Grossman and Sons, Inc.	..	..	$350.0	..
*Aug. 7	Roseburg, Oreg., Garretson Building Supply Co., et al	13	125	10,000.0	..
*Sep. 15	Clearfield, Pa., Sault Wholesale Lumber Co.	..	..	680.0	..
Nov. 8	McKeesport, Pa., H. C. Smith Co.	..	1	340.0	..
	Chemical and Drug Warehouses				
Mar. 17	St. Joseph, Mo., Woodbury Chemical Co.	..	2	300.0	..
May 22	Atlanta, Ga., Zep Manufacturing Co.	..	4	420.0	..
*Jul. 30	Portland, Conn., Portland Chemical Co., Subsidiary of Phillipp Bros. Chemicals Inc.	..	10	250.0	..
	Cold Storage				
Jan. 21	Frelighsburg, P.Q., Apple Growers Co-operative	..	..	701.5	..
*Mar. 7	Yuma, Ariz., Southwestern Ice & Cold Storage Co.	..	2	413.5	..
	Cotton Storage				
Mar. 18	Athens, Ga., Gulf-Atlantic Warehouse Co.	..	1	650.0	..
	Department Store Warehouses				
*May 15	Schenectady, N.Y., Fox and Murphy Sporting Goods Store, et al	..	4	516.5	$128.5
Jun. 17	Kodiak, Alaska, U.S. Naval Station	..	..	518.5	..
	Electrical Equipment Warehouses				
Mar. 30	Minneapolis, Minn., Globe Plumbing Supply Co.	..	8	316.0	..
*May 15	Ottawa, Ont., Dept. of Transport, Radio Division, et al	..	..	789.5	..
Aug. 19	Delaware Twp., N.J., Flynn's Camden Electrical Supply Co.	..	..	255.0	..
	Food and Grocery Warehouses				
Jan. 13	Wellington Village, Ont., United Canners, Ltd.	..	..	338.0	..
May 9	Baltimore, Md., B. Green & Co., Inc.	..	..	1,140.0	..
Jun. 14	Gary, Ind., Indiana Wholesale Food Corp.	..	1	464.0	..
Jun. 15	York Twp., Ont., Dominion Stores, Ltd.	..	..	1,214.5	..
Jun. 17	Philadelphia, Pa., New Yorker Cheese Products Co., et al	..	..	1,612.0	250.0
	Furniture Warehouses				
Apr. 22	Ottawa, Ont., Boyd Security Storage, Ltd.	..	..	299.5	..
Apr. 24	Albany, N.Y., Breslaw Realty Co., Inc.	1	2	250.0	..
Aug. 23	Fayetteville, N.C., Greyvan Lines, Inc.	..	..	335.0	..
Dec. 25	New York, N.Y., Burgher & Klien	..	2	271.0	..

Table II — Continued

Date	Place and Occupant	No. Dead	No. Injured	Property Damage In Thousands	Insured Indirect Loss
	Feed, Hay and Seed Storage				
Jun. 14	Charlotte, Mich., Moorman Feed Co., et al	..	..	$275.0	..
*Aug. 23	near Corvallis, Oreg., Oregon Seed Co.	..	..	306.0	..
	Grain Elevators				
May 10	Plentywood, Mont., Occident Elevator & Warehouse	..	..	280.0	..
*Aug. 3	Toledo, Ohio, Bendig Steel Drum Co.	..	..	352.0	$1.0
*Sep. 9	Lenore, Idaho, Lenore Grain & Seed Growers, Inc.	..	..	285.0	25.0
*Sep. 12	Vermillion, S.Dak., Bartlett Grain Co., et al	..	..	250.0	..
	Hardware Warehouses				
Feb. 3	Atlanta, Ga., American Motors Sales Corp.	..	1	871.5	..
Feb. 22	London, Ont., F. B. Dixon & Co., et al	..	1	463.0	..
Mar. 3	Philadelphia, Pa., Marine Equipment and Supply Co.	..	4	300.0	..
*Apr. 14	Ajax, Ont., General Motors of Canada	..	..	1,498.5	..
*Dec. 24	Montreal, P.Q., Herman Salvage Co., et al	..	..	250.0	..
	Liquor Storage				
*Dec. 25	Warsaw, Ky., Smith Distributing Co.	1	20	1,250.0	..
	Machinery Warehouse				
May 15	Detroit, Mich., Globe Trading	..	..	250.0	..
	Miscellaneous Storage				
Jan. 2	District of Franklin, Nw.T. Federal Electrical Corp., et al	..	..	900.0	..
	Multiple Occupancy Warehouse				
Mar. 8	Reading, Pa., M. J. Earle, Inc.	..	3	300.0	..
	Paper Warehouses				
*Apr. 17	Pittsburgh, Pa., The Paper Craft Corp.	..	7	700.0	Yes
Aug. 7	Chester, Pa., Scott Paper Co.	..	14	430.0	..
	Plastic and Plastic Products Warehouse				
Feb. 17	Scarborough, Ont., Columbia Records, Ltd.	..	..	495.5	..
	Rubber and Rubber Products Storage				
*Jun. 24	Chelsea, Mass., Tire Corporation of America	..	..	304.0	..
Dec. 19	New Village, N.J., Pennsylvania Tire Co.	..	..	850.0	..
	Terminal Warehouses				
Mar. 20	Jersey City, N.J., Woodward Terminal	..	2	400.0	..
Mar. 27	Blackpool, P.Q., Maislin Bros. Transport Ltd.	..	..	1,500.0	..
*Jul. 6	Pictou, N.S., Magdalen Island Transport Co. Ltd.	..	15	1,680.0	..
Jul. 8	St. John's, N.F. Canadian National Railways	..	..	250.0	..
Aug. 5	Tonawanda Twp., N.Y., Liberty Motor Freight Lines	..	3	250.0	..
*Sep. 6	Chicago, Ill., Watson Bros. Transportation Co.	..	..	1,250.0	..
*Sep. 9	Jersey City, N.J., Wheeling Transportation Inc.	..	15	1,000.0	..
	Tobacco Warehouses				
Jan. 6	Danville, Va., Farmers Warehouse	..	..	298.5	..
Aug. 14	W. Marietta, Pa., Lancaster Leaf Tobacco Co.	..	2	425.0	..
	Wastepaper and Rag Warehouse				
*May 6	Los Angeles, Calif., Sanfren Wool Stock Co.	..	6	390.0	..

Table II — Continued

The Large Residential and Institutional Fires of 1959

	Total No. of Fires	Total No. Killed	Total No. Injured	Total Property Damage Loss	Total Insured Indirect Loss
U. S. Losses	14	12	63	$6,913.5	$137.5
Canadian Losses	3	0	6	955.0	0.0
Total Losses	17	12	69	$7,868.5	$137.5

Date	Place and Occupant	No. Dead	No. Injured	Property Damage In Thousands	Insured Indirect Loss
	Apartment Buildings				
Jul. 25	Ware, Mass., Hitchcock Block	..	3	$250.0	..
	Dormitories				
Jan. 23	State College, Miss., Mississippi State College	1	1	1,030.0	..
Feb. 27	Halifax, N.S., Stadacona Naval Base	..	..	453.0	..
Dec. 9	Tarkio, Mo., Tarkio College	..	..	250.0	..
	Dwellings				
May 3	North York Twp., Ont., Samuel Fingold	..	2	252.0	..
	Hospitals				
Sep. 12	Port Sulphur, La., Plaquemines Parish Hospital	..	3	700.5	..
	Hotels				
	Continuous Operation				..
Jan. 8	Greenfield, Mass., Mansion House Hotel	..	3	366.0	$10.0
Jan. 17	Detroit, Mich., Tuller Hotel	4	13	500.0	..
Feb. 8	Cleveland, Ohio, Ritzwood Hotel	..	2	430.0	17.5
Feb. 12	Lewiston, Mont., Burke Hotel	..	..	250.0	..
Jun. 3	Garrison, N.Y., Bill Brown's Health Farm	1	3	250.0	..
	Seasonal Operation				
*Feb. 19	Atlantic City, N.J., Royal Palms Hotel, Inc.	..	4	420.0	110.0
*Jun. 20	Twp. 136, near Brainerd, Minn., Breezy Point Lodge	2	22	1,045.0	..
Aug. 14	Punta Gorda, Fla., Charlotte Harbor Spa & Hotel	..	..	712.0	..
Aug. 16	near Gravenhurst, Ont., Muskoka Beach Inn	..	4	250.0	..
*Sep. 27	Sayville, N.Y., Sayville Plaza Hotel	..	8	450.0	..
	Nursing Home				
Mar. 13	Aurora, Ill., Jennings Terrace Home	4	6	260.0	..

Table II — Continued

The Large Educational Fires of 1959

	Total No. of Fires	Total No. Killed	Total No. Injured	Total Property Damage Loss	Total Insured Indirect Loss
U. S. Losses	15	0	38	$6,039.5	$0.0
Canadian Losses	3	0	0	941.5	0.0
Total Losses	18	0	38	$6,981.0	$0.0

Date	Place and Occupant	No. Dead	No. Injured	Property Damage In Thousands	Insured Indirect Loss
	Colleges and Universities				
Jan. 18	Chili, N.Y., Roberts Wesleyan College (Chili Plastics, Inc.)	..	2	$311.0	..
Dec. 29	Cazenovia, N.Y., Cazenovia Junior College	..	..	300.0	..
	Parochial Schools				
Apr. 15	Mattawa, Ont., R.C.E.C. St. Anne School	..	..	356.5	..
Jul. 23	Burns Lake, B.C., Immaculata Roman Catholic School	..	..	300.0	..
	Private Schools				
Jan. 29	Tewksbury, Mass., Catholic Oblate Mission House	..	..	325.0	..
Sep. 22	Cromwell, Conn., Holy Apostles Seminary	..	9	250.0	..
Dec. 23	Lawrenceville, N.J., Lawrenceville School	..	..	350.0	..
	Public Schools				
Jan. 31	Strandquist, Minn., Strandquist School	..	..	300.0	..
Feb. 2	Bristol Twp., Pa., Delhaas High School	..	4	900.0	..
Feb. 6	Donaldson, Pa., Frailey Township School	..	..	500.0	..
Mar. 13	California, Pa., Phillipsburg School	..	..	420.0	..
Apr. 3	near Sharon, Kans., Public School Dist. No. 28	..	..	320.0	..
May 31	San Francisco, Calif., Jefferson School	..	22	343.0	..
Jun. 5	Cedar Grove, N.J., Pompton Avenue School	..	..	500.0	..
Jul. 15	Fall River, Mass., Longfellow School	..	..	466.5	..
Sep. 20	Nelson, B.C., South Nelson Elementary School	..	..	285.0	..
Dec. 4	Springfield, Tenn., Bransford High School	..	1	279.0	..
Dec. 14	Columbus, Miss., Lee Junior High School	..	..	475.0	..

The Large Church Fires of 1959

	Total No. of Fires	Total No. Killed	Total No. Injured	Total Property Damage Loss	Total Insured Indirect Loss
U. S. Losses	6	0	0	$1,833.0	$0.0
Canadian Losses	4	0	10	1,177.5	0.0
Total Losses	10	0	10	$3,010.5	$0.0

Date	Place and Occupant	No. Dead	No. Injured	Property Damage In Thousands	Insured Indirect Loss
	Churches				
Jan. 3	St. Jean de Dieu, P.Q., L'eglise de St. Jean de Dieu	..	..	$283.5	..
Jan. 9	Chicago, Ill., Sacred Heart Church	..	..	250.0	..
*Jan. 14	Washington Court House, Ohio, Grace Methodist Church	..	..	340.0	..
*Jan. 21	Ridgewood, N.J., First Reformed Church of Ridgewood	..	..	255.0	..
Apr. 20	Westphalia, Mich., St. Mary's Catholic Church	..	..	400.0	..
Aug. 4	Richmond, Ky., First Christian Church	..	..	338.0	..
Aug. 16	Timmins, Ont., Notre Dame De Lourdes Church	..	9	250.0	..
Sep. 8	Mattawa, Ont., St. Anne's Catholic Church	..	..	340.0	..
Nov. 1	Waterloo, Ont., St. John's Evangelical Lutheran Church	..	1	304.0	..
Dec. 27	Liebenthal, Kans., St. Joseph's R. C. Church	..	..	250.0	..

Table II — Continued

The Large Transportation Fires of 1959

	Total No. of Fires	Total No. Killed	Total No. Injured	Total Property Damage
U. S. Losses	46	130	41†	$138,490,000
Canadian Losses*	1	5	0	500,000
Total Losses	47	135	41	$138,990,000

Aircraft (See Key to Abbreviations, next page)

Date	Place	Type Accident	Operator	Type Aircraft	Estimated Loss	Number Killed Aboard Aircraft	Number Killed On Ground
Jan. 10	Martinsburg Municipal Airport, Martinsburg, W. Va.	CF	W. Va. ANG	F-86H-1	$ 580,000	1	0
Jan. 17	Miami International Airport, Miami, Fla.	FF	EAL	Constellation 1049G	1,000,000	0	0
Jan. 18	Elmendorf AFB, Anchorage, Alaska	GF	USAF	KC-97	1,200,000	0	0
Jan. 20	nr. Ottawa, Kans.	FF	USN	Patrol Bomber	1,000,000	0	0
Jan. 22	nr. England AFB, La.	FF	USAF	KC-50	1,500,000	6	0
Jan. 24	Akron-Canton Airport, North Canton, Ohio	CF	USAF	C-54E	380,000	0	0
Jan. 29	Castle AFB, Calif.	CF	USAF	B-52	14,400,000	0	0
Feb. 16	Naval Air Station, Oceana, Va.	FF	USN	F9F-8T	350,000	0	0
Feb. 17	nr. Pinetown, N.C.	CF	USN	ZS2G-1 Airship	2,500,000	4	0
Feb. 20	San Francisco International Airport, S. San Francisco, Calif.	CF	PAA	DC-7	2,000,000	0	0
Feb. 28	nr. Prescott, Ariz.	CF	USN	C-121G	2,250,000	5	0
Mar. 6	nr. Marine Corps Air Station, Cherry Pt., N. C.	CF	USMC	R4Q-2	500,000	8	0
Mar. 15	nr. Chicago Midway Airport, Chicago, Ill.	CF	AA	Convair 240	500,000	0	0
Mar. 24	nr. Petit Jean Mountain, Ark.	EF	USAF	B-47	2,500,000	0	0
Mar. 29	Naval Air Sta., Argentia, N. F.	CF	USN	WV-2	2,250,000	0	0
Mar. 30	nr. Alma, Ga.	FF	Riddle	C-46R	250,000	2	0
Apr. 1	nr. Alderton, Wash.	FF	USAF	C-118	1,200,000	4	0
Apr. 2	Naval Air Sta., Argentia, N. F.	CF	USN	WV-2	2,250,000	1	0
May 11	Naval Air Sta., Whidbey Island, Wash.	FF	USN	P2V-5	1,000,000	9	0
May 12	Kanawha Airport, Charleston, W. Va.	CF	CAP	Constellation	1,000,000	2	0
May 14	Fort Worth, Tex.	GF	Convair	B-58	10,000,000	1	0
May 19	nr. Woonsocket, R. I.	EF	USAF	F-89	1,000,000	0	0
May 28	Aboard Carrier "Essex," nr. Jacksonville, Fla.	CF	USN	FJ-Fury and 5 others	3,000,000	2	0
Jun. 22	Walker AFB, Roswell, N. M.	GF	USAF	KC-135	6,000,000	0	0
Jul. 6	Parksdale AFB, Shreveport, La.	CF	USAF	C-124	2,000,000	0	0
Jul. 14	Wold-Chamberlain Airport, Minneapolis-St. Paul, Minn.	GF	NWA	Boeing 377	1,500,000	0	0
Jul. 22	E. Andover, N. H.	EF	USAF	KC-97	1,200,000	7	0
Jul. 30	S. Weymouth, Mass.	CF	USN	HSS-1	380,000	1	0
Aug. 13	Aboard USS "Wasp," Off the Virginia Coast	GF	USN	3 HSS-1's and 1 HUK	3,000,000	1	0
Sep. 16	Carswell AFB, Tex.	GF	USAF	B-58	24,000,000	2	0

* Does not include losses to U. S. aircraft in Canada.
† Aircraft Injuries not included.

Table II — Continued

Date	Place	Type Accident	Operator	Type Aircraft	Estimated Loss	Number Aboard Aircraft	Number Killed On Ground
Sep. 26	nr. Astoria, Oreg.	FF	USN	Patrol	$ 500,000	0	0
Sep. 29	nr. Buffalo, Tex.	EF	Braniff	Electra	2,300,000	34	0
Oct. 2	nr. Stewart AFB, N. Y.	CF	USAF	B-57	1,100,000	2	0
Oct. 5	Naval Air Sta., Oceana, Va.	CF	USN	HUP	300,000	2	0
Oct. 8	Lincoln AFB, Nebr.	CF	USAF	B-47	3,500,000	4	0
Oct. 15	nr. Naval Air Sta., Jacksonville, Fla.	CF	USOA	DC-4	500,000	0	0
Oct. 19	nr. Arlington, Wash.	FF	Boeing	707-227	4,000,000	4	0
Oct. 21	Navy Auxiliary Air Sta., Charlestown, R. I.	CF	USN	S2F-1	600,000	0	1
Oct. 21	Dobbins AFB, Ga.	CF	USAF	B-47	2,500,000	0	0
Oct. 28	nr. Hattiesburg, Miss.	EF	USAF	B-58	10,000,000	1	0
Nov. 5	near St. Cleophas de Brandon, Que.	FF	Wheeler	DC-4	500,000	5	0
Nov. 8	nr. Lawton, Okla.	EF	Convair	B-58	10,000,000	2	0
Nov. 17	nr. Whiteman AFB, Mo.	FF	USAF	TB-47	2,500,000	4	0
Nov. 24	Chicago, Ill.	FF	TWA	Constellation	1,000,000	3	9
Dec. 12	Cape Canaveral, Fla.	GF	USAF	Titan C-3 Missile	2,000,000	0	0
Dec. 21	Los Gatos, Calif.	EF	USN	F8U	1,000,000	0	0
					$132,990,000	117	10

	Ships	Property Damage	Number Killed	Number Injured
Nov. 8	Galenia Park, Tex., Tanker "Amoco Virginia"	$6,000,000	8	41

Key to Abbreviations

Type Accident
- CF — Crash Fire
- EF — Explosion in Flight
- FF — Fire in Flight
- GF — Ground Fire

Military Operators
- ANG — Air National Guard
- USAF — United States Air Force
- USMC — United States Marine Corps
- USN — United States Navy

Civil Operators
- AA — American Airlines
- CAP — Capital Airlines
- EAL — Eastern Air Lines
- NWA — Northwest Airlines
- PAA — Pan American Airways
- TWA — Trans World Airways
- USOA — United States Overseas Airways

NOTE: Aircraft type designations for military aircraft are the official designations used by the United States Military Services. The following are further identifications of the aircraft on this year's list.

USAF and ANG Aircraft Designations
- B — Bomber
- C — Cargo or Transport
- F — Fighter
- KC — Tanker (Airborne Refueling)

USN Aircraft Designations
- F8U — Chance Vought Crusader
- F9F — Grumman Cougar
- FJ — North American Fury
- HSS-1 — Sikorsky S-58 Helicopter
- HUK — Kaman Helicopter
- HUP — Vertol Helicopter
- P2V-5 — Lockheed Neptune
- R4Q — Fairchild Packet (USAF:C-119G)
- S2F — Grumman Traeker
- WV-2 — Lockheed Super Constellation Radar Picket (USAF:C-121)
- ZS2G — Goodyear Anti-Submarine Warfare Airship

Table II — Continued

The Other Large Fires of 1959

	Total No. of Fires	Total No. Killed	Total No. Injured	Total Property Damage Loss	Total Insured Indirect Loss
U. S. Losses	58	8	115	$60,508.5	$115.0
Canadian Losses	4	0	0	1,560.5	0.0
Total Losses	62	8	115	$62,069.0	$115.0

Date	Place and Occupant	No. Dead	No. Injured	Property Damage In Thousands	Insured Indirect Loss
	Armories				
Feb. 3	Ishpeming, Mich., National Guard Armory	..	..	$667.0	..
Nov. 3	near Welch, W.Va., National Guard Armory	..	..	512.5	..
	Auditoriums				
*Apr. 11	Zion, Ill., Christian Catholic Church	..	4	1,075.0	..
	Banks				
Dec. 12	Bell, Calif., Bank of America	..	..	375.0	..
	Bowling Alleys				
Feb. 2	Rahway, N.J., Rahway Recreation Center	..	2	429.0	..
Feb. 2	Hyde Park, N.Y., Hoe-Bowl Country Lanes	..	1	375.5	..
Feb. 23	Waterford Twp., Mich., Huron Bowl	..	1	600.0	Yes
Mar. 4	Raleigh, N.C., Manmur Bowling Center	..	2	250.0	..
	Clubs				
City					
Jan. 11	Des Moines, Iowa, Elks Club	..	5	295.0	..
Feb. 10	Bennington, Vt., Bennington Club, et al	..	..	509.0	..
Country					
Jan. 22	Palatine, Ill., Inverness Country Club	1	..	280.0	..
*May 11	Fairlee Creek, Md., Great Oak Lodge	..	..	277.0	..
Nov. 10	Southfield, Mich., Plum Hollow Golf Club	..	4	375.0	..
Nov. 10	near Memphis, Tenn., Fox Meadow Country Club	..	..	350.0	..
Night					
Aug. 27	Miami Beach, Fla., Latin Quarter Night Club	..	3	400.0	..
	Forest and Brush Fires				
Jun. 6	Tonto National Forest, Ariz.	..	..	600.0	$650.0†
*Jun. 12	Kenai Lake Fire, Alaska	..	..	729.5	103.5†
Jun. 19	Big Creek Fire, Alaska	..	..	367.0	..
Jul. 2	Tahoe National Forest, (Cold Creek Fire), Calif.	..	..	326.0	..
*Jul. 10	Los Angeles, Calif., Laurel Canyon	..	9	1,095.0	..
Jul. 11	Sequoia National Forest, (Dry Fire), Calif.	..	..	418.0	..
Jul. 21	Aspen Flat Fire, Oreg.	..	..	337.0	..
*Jul. 24	St. Anne des Monts Parish, P.Q.	..	..	536.0	263.5†
Jul. 25	Shasta-Trinity National Forest (Ramshorn Fire), Calif.	..	..	1,980.0	..
Jul. 28	Sierra National Forest, (Nelson Cove Fire), Calif.	..	..	366.0	..
Jul. 28	Shasta-Trinity National Forest, (Drake Fire), Calif.	..	..	782.0	..
Aug. 2	Plumas National Forest, (Twain Fire), Calif.	..	..	345.5	..
Aug. 7	Shasta-Trinity National Forest, (Frethy Fire), Calif.	..	..	665.0	..
Aug. 8	Shasta-Trinity National Forest, (Jones Fire), Calif.	..	..	1,174.0	..
Aug. 8	Shasta-Trinity National Forest, (Lava Fire), Calif.	..	..	855.0	..
Aug. 8	Ashland Watershed, Oreg.	..	..	250.0	..
Aug. 9	Crooked Creek SE-30 Fire, Alaska	..	..	624.0	..
Aug. 11	Plumas National Forest, (Charles Fire), Calif.	..	..	429.5	..
*Sep. 8	Black Hills National Forest, (Deadwood), S.Dak.	..	1	1,558.0	300.0†
Oct. 13	Angeles National Forest, (Woodwardia Fire) Calif.	2	..	18,773.0	1,450.0†

† Cost of suppression (not insured)

Table II — Continued

Date	Place and Occupant	No. Dead	No. Injured	Property Damage In Thousands	Insured Indirect Loss
Oct. 29	Eldorado National Forest, (Camp 7 Fire), Calif.	..	..	$1,010.0	..
*Oct. 29	Eldorado National Forest, (Ice House Fire), Calif.	..	..	1,750.0	..
Oct. 31	Tahoe National Forest, (Mf. House Fire), Calif.	..	..	3,099.0	..
	Garage				
Mar. 17	Cadillac, Mich., Municipal Garage	..	..	260.0	..
	Gas Distributing Station				
*Mar. 12	Brinkley, Ark., Weis Butane Gas Co., et al	1	12	250.0	..
	Gas Wells, Pipe Lines, and Storage				
Aug. 1	off Houma, La., Gracey-Hellums Co.	3	5	1,500.0	..
	Hangars				
*Dec. 10	St. Laurent, P.Q., Curtis-Reid Flying Service, et al.	..	..	350.0	..
Nov. 4	Regina, Sask., Canadian Aircraft Co.	..	..	413.0	..
	Laboratories				
Feb. 10	Aberdeen, Md., Aberdeen Proving Ground	..	..	250.0	..
Feb. 20	Baltimore, Md., Baltimore Biological Laboratory	..	2	350.0	..
Apr. 25	East Hartford, Conn., United Aircraft Co.	1	..	375.0	..
Nov. 20	Oak Ridge, Tenn., Oak Ridge National Laboratory	..	9	260.0	..
	Laundries				
Jan. 29	Salinas, Calif., Mission Linen Supply	..	..	250.0	..
*Mar. 6	Indianapolis, Ind., Pilgrim Laundry, et al	..	..	329.5	$40.0
*Aug. 26	Ottawa, Ill., Illinois Laundry and Cleaning Co., et al	..	3	292.0	Yes
	Lumberyards				
*Apr. 4	Carmi, Ill., E. C. Robinson Lumber Co.	..	1	250.0	..
*Jun. 23	Rapid City, S.Dak., Knecht Lumber Co.	..	1	399.5	..
*Aug. 22	Ogden, Utah, Ogden Builders Supply Co., et al	..	3	265.5	..
	Motion Picture Studio				
Sep. 8	Los Angeles, Calif., U.S. Air Force Lookout Mountain Laboratory	..	..	493.5	..
	Office Buildings				
Feb. 17	Wichita, Kans., Boeing Airplane Co.	..	..	880.0	Yes
Jun. 13	Laurel, Md., U.S. Gov't Analysis Laboratory & Office	..	..	254.0	..
Jul. 2	Arlington, Va., The Pentagon Building	..	35	6,690.0	..
Nov. 19	Alexandria, La., Dept. of Agriculture Bldg.	..	..	450.0	..
	Piers and Wharves				
Jul. 31	New York, N.Y., City of New York, Dept. of Sanitation	..	..	1,401.0	..
	Public Buildings				
May 31	Bayonne, N.J., Bayonne Public Library	..	7	425.0	..
Nov. 12	Sydney, N.S., Cape Breton County Court House	..	..	261.5	..
	Vacant Building				
*Jul. 19	Tacoma, Wash., Former Wheeler-Osgood Door Factory, et al	..	5	580.0	75.0

Fire Record of Cities, 1959

As Reported by Municipal Authorities

The following tables summarize fire department reports for 1959 in 657 of the 700 cities with population over 20,000 in the United States and Canada.

These statistics have been collected and published in the April QUARTERLIES since 1939. These tables should not be used as a basis for comparing cities, as a comparison based on these statistics may be misleading if used without a full understanding of the many factors which should be taken into consideration. The principal discrepancy results from the wide variation among fire officials as to what constitutes a fire loss. Certain reports include only insured losses, others only uninsured. Whether or not property is insured has no bearing on the actual value of property destroyed. The chance effect of a single large loss fire, differences in degree of industrialization, in topography, climate and age of cities are some of the factors that influence the fire record. In other words, fire losses reflect the composite results of many factors in addition to fire department efficiency and therefore the practice of making comparisons among different cities based on these data is to be discouraged.

In recent years the 1950 census figures have been used in compiling the statistics for this annual study. In order to increase the accuracy of current figures the population estimates for 1959 were used. The 1958 statistics cited are based on 1958 population estimates.

Fire departments of 541 United States cities and 43 Canadian cities of over 20,000 population have reported their estimates of fire loss, fire alarms, building fires, and false alarms for 1959 to the NFPA Department of Fire Record.

A total of 556 United States cities reported a fire loss for the year 1959 of $205,242,000. Fifty Canadian cities reported a loss of $29,782,000.

The average loss per person in the 556 U.S. cities reporting losses was $3.94, 5.1 per cent less than the $4.15 average loss in 1958. The per capita loss in the 50 Canadian cities reporting losses was $5.05, an 8.8 per cent increase from 1958.

The average loss per building fire in 503 U.S. cities for 1959 was $982, compared with $1,092 in 1958, and $1,085 in 1957. The average building fire loss in 49 Canadian cities was $1,387 in 1959, $1,155 in 1958, $1,625 in 1957.

The total number of building fires reported by 574 U. S. cities was 259,853 an average of 3.8 fires per 1,000 population, compared with 3.7 building fires per 1,000 population in 1958. Forty-nine Canadian cities reported 21,654 building fires in 1959. The number per 1,000 population was 3.7 in 1959, the same as in 1958.

Motor vehicle fires reported by 567 U.S. cities totaled 80,882, an average of 1.20 fires per 1,000 population. Forty-five Canadian cities reported 4,836 motor vehicle fires, or 0.85 per 1,000.

Fire departments in 577 U.S. cities of more than 20,000 population answered 1,023,408 alarms in 1959. The number of alarms in 50 Canadian cities was 72,319.

In the United States, 570 cities of over 20,000 reported 94,452 false alarms in 1959. This was 9.2 per cent of the total calls. It will be noted that these are *"malicious false alarms," not* cases where smoke or steam, etc., was honestly mistaken for fire. The 10,143 false alarms reported by 45 Canadian cities were 14.0 per cent of their total calls.

Fire departments have been very cooperative in furnishing fire loss figures. Most of the 43 nonreporting cities did not record their fire experience. A number of loss figures are indicated in the Tables as preliminary estimates.

1959 FIRE LOSSES, CITIES OF 20,000 POPULATION AND OVER

As Reported by Municipal Authorities

City	Total Loss in 1,000's	No. Alarms	Bldg. Fires	False Alarms	Bldg. Fires/ 1,000 Pop.
ALABAMA					
Anniston	173	631	175	39	5.0
Bessemer	81	322	102	23	2.9
Birmingham	1,489	4,645	1,178	442	4.6
Dothan City	157	445	210	13	9.8
Florence	...	566	148	23	6.2
Gadsden	208	853	208	87	3.2
Mobile	487c	1,799	705	150	4.0
Montgomery	228d	1,342	550	107	5.2
Phenix City	...	...	...	...	..
Selma	36	263	103	13	3.7
Tuscaloosa	66	463	224	40	4.8
ARIZONA					
Phoenix	974a,c	4,129	938	235	2.5
Tucson	237	2,311	300	172	6.7
ARKANSAS					
El Dorado	89	446	107	16	4.1
Fort Smith	375	1,104	214	31	3.6
Hot Springs	89c	367	151	22	4.7
Little Rock	...	2,086	610	391	4.6
N. Little Rock	699	1,410	238	53	4.0
Pine Bluff	167d	816	252	21	6.8
CALIFORNIA					
Alameda	149	793	78	97	1.1
Alhambra	38	534	149	83	2.6
Arcadia	279a	691	126	170	3.1
Bakersfield	157c	1,201	220	128	4.1
Berkeley	501	2,194	497	100	4.1
Beverly Hills	328	605	98	44	3.1
Burbank	485	1,339	350	98	3.8
Compton	170	646	201	15	2.9
Eureka	...	...	...	...	..
Fresno	566c	1,490	613	290	6.8
Glendale	126c	1,061	326	113	3.4
Hayward[1]	104	1039	188	26	2.8
Huntingt'n Pk.	...	...	...	...	..
Inglewood	154c	866	163	18	3.5
Long Beach	878c	2,134	980	116	3.0
Los Angeles	...	37,113	6,270	2,383	3.2
Los Angeles Cty	...	...	...	...	..
Lynwood	98c	280	89	11	3.5
Menlo Pk. F.D.	228	1,057	184	30	2.9
Monrovia	49	403	105	4	3.9
Montebello	136	465	90	19	2.8
Monterey Park	17	436	102	8	2.7
National City	39	315	58	6	1.7
Oakland	2,011c	6,913	1,793	916	4.4
Ontario	156c	1,105	142	20	6.2
Oxnard	43c	204	99	4	2.7
Palo Alto	466	794	254	41	4.7
Pasadena[2]	235	1,197	443	150	3.6
Pomona	73c	861	123	27	2.0
Redondo Beach	56	512	146	20	3.1
Redwood City	75	767	94	55	3.7
Richmond	177c	1,153	103	81	1.0
Riverside	...	593	177	43	2.0
Sacramento	815c	3,523	834	351	6.2
San Bernardino	248c	1,303	314	111	3.3
San Diego	1,246a,c	5,203	1,676	305	3.0
San Francisco	...	14,023	3,277	2,711	4.2
San Gabriel	110	434	50	11	2.2
San Jose	670c	3,689	417	213	2.2
San Leandro	291	967	196	18	7.2
San Mateo	119c	862	290	32	4.1
Santa Ana	108c	1,410	230	140	5.1
Santa Barbara	122c	1,021	240	55	4.0
Santa Cruz	32	364	81	23	3.7
Santa Monica	235	1,066	315	158	3.6
South Gate	134c	838	221	14	4.1
Stockton	237c	2,010	331	123	3.7
Torrance	174	791	212	8	2.1
Vallejo	146	1,343	208	159	8.7
Whittier	38	385	94	1	2.7
COLORADO					
Colorado Sp.	130	745	306	63	6.8
Denver	925a	5,969	1,882	617	3.8
Greeley	51c	229	128	13	6.1
Pueblo	134a	641	304	63	3.0
CONNECTICUT					
Bridgeport	629	2,057	567	185	3.6
Bristol	...	...	...	...	..
Danbury	39c	357	108	27	4.5
East Hartford	118	510	107	33	2.7
Fairfield	151	725	194	8	4.2
Greenwich	263	734	181	8	4.5
Hamden	104	623	30	27	0.7
Hartford	716	2,571	493	237	2.8
Manchester	86	307	106	11	2.5
Meriden	275	505	181	26	3.5
Middletown	...	...	...	...	..
Milford	84	813	86	50	2.0
New Britain	132	971	117	82	1.3
New Haven	617	2,647	352	17	2.1
New London	178a	526	151	48	4.7
Norwalk	...	896	266	51	4.1
Norwich	51	394	129	16	4.6
Stamford	702	1,111	131	60	1.8
Stratford	47	584	119	3	2.6
Torrington	95	312	43	11	1.6
Waterbury	542	1,817	447	131	4.3
West Hartford	107a	648	71	23	1.2
W. Haven Twp.	50	564	51	44	1.3
DELAWARE					
Wilmington	301	1,363	757	...	6.9

a. Estimated. c. Buildings and contents only. d. Insured loss only.

1. Fiscal year ended June 15, 1959. 2. Fiscal year ended June 30, 1959.

City	Total Loss in 1,000's	No. Alarms	Bldg. Fires	False Alarms	Bldg. Fires/ 1,000 Pop.
DISTRICT OF COLUMBIA					
Washington	2,077	11,632	2,241	1,462	2.6
FLORIDA					
Daytona Beach	210b	478	108	19	3.7
Ft. Lauderdale	178c	572	122	28	1.2
Gainesville	29	317	123	21	3.5
Jacksonville	862	3,287	706	234	3.0
Key West	78	184	35	19	0.7
Lakeland	46	387	105	55	3.4
Miami	39	2,862	825	136	3.3
Miami Beach	330c	829	261	48	5.7
Orlando	226	981	120	84	1.3
Panama City	216	366	77	11	2.2
Pensacola	1,619	377	193	0	3.7
St. Petersburg	359cd	1,829	352	34	3.7
Tallahassee	150e	699	131	26	4.8
Tampa	1,239ec	4,234	986	300	3.6
W. Palm Beach	136	504	63	26	0.9
GEORGIA					
Albany	100	856	374	60	8.1
Athens	...	...	...	...	..
Atlanta	3,432	6,920	2,092	515	6.4
Augusta	306	996	423	77	5.9
Columbus	275c	1,157	457	155	3.4
Decatur	36	324	74	3	3.0
East Point	138	482	132	66	3.8
La Grange	54	377	44	17	1.8
Macon	199	721	298	95	4.3
Marietta	31c	453	138	62	3.3
Rome	349c	489	180	52	6.1
Savannah	534	1,579	...	219	..
Valdosta	174	386	138	23	3.9
IDAHO					
Boise	355c	839	92	17	2.6
Pocatello	5	319	128	13	4.9
ILLINOIS					
Alton	226	421	206	9	5.7
Aurora	502	1,033	240	77	3.9
Belleville	68	416	154	4	4.7
Berwyn	205c	354	125	20	2.2
Bloomington	62c	1,389	191	33	5.6
Champaign	162	438	220	30	5.6
Chicago	...	96,259	21,218	12,462	5.7
Chicago Hts.	...	...	...	...	..
Cicero	...	770	215	206	3.2
Danville	279	995	254	7	6.2
Decatur	224	840	436	20	5.7
East St. Louis	341	1,267	534	108	5.9
Elgin	111	612	67	16	1.3
Elmhurst	64c	173	73	...	2.1
Evanston	206	1,252	343	478	4.6
Freeport	40	738	78	7	3.0
Galesburg	2,827	391	136	12	4.4
Granite City	...	...	...	...	..
Harvey	16	507	63	20	2.4
Jacksonville	31	180	74	8	3.7
Joliet	328	2,348	70	65	1.3
Kankakee	108	1,025	93	10	3.1
Maywood	46	154	50	12	1.7
Moline	76	1,034	211	73	4.9
Oak Park	153	1,017	231	15	3.7
Ottawa	505	368	44	...	2.0
Pekin	52	296	81	6	3.7
Peoria	599	1,803	442	192	4.0
Quincy	183	451	118	13	2.6
Rockford	418	1,433	610	95	5.3
Rock Island	204	632	140	29	2.8
Springfield	401	1,167	507	41	5.9
Urbana	73	278	52	15	2.3
Waukegan	96	1,224	196	14	3.9
INDIANA					
Anderson	323c	744	383	70	7.2
Bloomington	64	468	155	13	3.4
East Chicago	433	2,014	224	115	4.1
Elkhart	59	532	234	36	6.5
Evansville	1,044	1,709	537	179	3.6
Fort Wayne	263	2,203	982	201	7.4
Gary	752	3,337	704	478	3.9
Hammond	81c	3,680	313	186	2.8
Indianapolis	1,289c	7,754	2,540	318	5.5
Kokomo	79c	626	339	63	8.8
Lafayette	53	678	62	48	1.6
Logansport	23	456	150	51	7.2
Marion (e)	...	...	...	...	..
Michigan City	452	582	211	61	6.0
Mishawaka	207	509	121	57	3.7
Muncie	211c	1,130	...	...	..
New Albany	218	528	211	49	7.2
Richmond	65	668	237	72	6.0
South Bend	195	1,832	365	370	2.8
Terre Haute	348	1,451	481	71	6.0
IOWA					
Ames	41	246	123	14	5.3
Burlington	48	476	69	0	1.8
Cedar Rapids	433	811	352	57	4.9
Clinton	32	968	165	18	4.7
Council Bluffs	148	435	152	29	2.8
Davenport	196	1,102	427	132	5.8
Des Moines	1,659	2,516	619	100	2.9
Dubuque	64	786	253	40	4.2
Fort Dodge	...	...	...	...	..
Iowa City	64	316	102	0	2.9
Marshalltown	80	267	142	8	6.2
Mason City	176	474	84	7	2.7
Ottumwa	36	680	123	6	3.7
Sioux City	982	1,059	394	51	4.2
Waterloo	582a	1,549	361	149	4.8
KANSAS					
Hutchinson	164	698	159	14	4.3
Kansas City	519	1,659	521	37	4.0

a. Estimated. b. Incomplete. c. Buildings and contents only.
d. Insured loss only. e. Subject to change.

City	Total Loss in 1,000's	No. Alarms	Bldg. Fires	False Alarms	Bldg. Fires/ 1,000 Pop.
KANSAS (Continued)					
Lawrence	51	323	123	4	5.1
Leavenworth	126	368	128	13	5.6
Pittsburg	88	541	55	8	2.2
Salina	420	610	171	4	0.6
Topeka	324c	...	...	...	..
Wichita	1,267	4,226	720	101	2.8
KENTUCKY					
Ashland	...	...	...	...	..
Covington	181	891	366	109	5.7
Lexington	341c	3,012	479	121	8.8
Louisville	...	4,555	1,702	485	4.6
Newport	...	...	...	...	..
Owensboro	78e	705	293	29	8.6
Paducah	342	836	290	57	9.0
LOUISIANA					
Alexandria	323c	454	94	81	1.9
Baton Rouge	436	1,549	396	195	2.4
Lafayette	324	291	135	65	4.0
Lake Charles	389	816	242	67	5.9
Monroe	301ce	850	232	85	6.1
New Orleans	1,380	5,835	1,498	177	2.6
Shreveport	862	1,999	594	155	3.6
MAINE					
Auburn	87c	609	227	16	9.9
Augusta	48	432	165	25	7.2
Bangor	208	715	60	95	1.9
Biddeford	...	...	...	...	..
Lewiston	177	711	160	16	3.6
Portland	114	1,746	427	111	5.0
South Portland	180	795	184	91	7.4
MARYLAND					
Baltimore	5,480e	14,846	6,450	1,720	6.5
Cumberland	...	436	175	63	4.7
Hagerstown	72a	544	262	23	7.2
Montgo'y Cty	...	3,170	1,093	55	3.0
MASSACHUSETTS					
Arlington	94c	988	79	112	1.6
Attleboro	68	733	108	21	4.3
Belmont	63c	642	160	25	5.3
Beverly	...	...	...	...	..
Boston	...	...	...	...	..
Braintree	111	915	60	59	2.6
Brockton	174a	1,919	379	137	5.6
Brookline	301	1,372	517	110	9.1
Cambridge	80a	3,121	643	336	5.3
Chelsea	495	1,004	72	76	1.9
Chicopee	140d	827	150	92	3.1
Everett	200c	1,040	137	134	3.0
Fall River	495	1,599	316	138	2.8
Fitchburg	46e	1,904	123	49	2.9
Framingham	...	...	...	...	..
Gloucester	330	888	194	44	7.8
Haverhill	577c	1,586	479	143	10.1
Holyoke	166c	1,224	617	127	11.3
Lawrence	77	642	101	24	1.3
Leominster	68	1,380	271	32	11.1
Lowell	245c	1,788	432	124	4.5
Lynn	...	3,098	591	272	5.9
Malden	454a	1,463	101	87	1.7
Medford	629	1,969	245	220	3.7
Melrose	182	600	31	44	1.0
Methuen	38	642	141	24	5.8
Milton	35	609	107	48	4.1
New Bedford	703b	1,299	312	83	3.1
Newton	333a	1,922	561	81	6.2
North Adams	42	390	94	18	4.4
Northampton	...	504	171	53	5.7
Peabody	132a	812	183	29	8.5
Pittsfield	258b	970	256	68	4.6
Quincy	275	2,359	422	217	5.0
Revere	372	1,139	61	131	1.6
Salem	176c	894	78	48	1.9
Somerville	667	2,196	386	297	3.9
Springfield	564e	3,609	714	541	4.2
Taunton	190	879	187	64	4.4
Waltham	274	1,092	244	81	4.6
Watertown	176	1,050	111	62	3.9
Wellesley	160b	617	49	39	2.0
Westfield	31	748	93	14	4.4
W. Springfield	119	530	125	37	6.3
Weymouth	157a	1,115	105	69	2.2
Woburn	188	1,093	40	77	1.3
Worcester	417b	4,064	858	794	4.2
MICHIGAN					
Ann Arbor	241	720	362	5	5.3
Battle Creek	57	796	143	112	2.6
Bay City	265	854	281	22	4.9
Birmingham	69	453	57	4	2.2
Dearborn	461	1,181	221	143	1.6
Detroit	8,924ac	16,726	5,003	2,865	2.7
East Detroit	78	310	132	7	2.9
East Lansing	70	334	39	3	1.9
Ferndale	231	417	119	40	3.5
Flint	1,005c	2,105	624	178	3.1
Grand Rapids	448	1,488	229	78	1.3
Hamtramck	256	681	188	61	4.4
Highland Park	96c	873	225	100	4.9
Jackson	359	720	320	62	6.3
Kalamazoo	224c	1,039	172	30	2.1
Lansing	263c	3,409	409	106	3.5
Lincoln Park	83	536	138	42	2.7
Monroe	52	299	144	23	6.3
Muskegon	172	769	117	70	2.3
Pontiac	514	1,770	399	186	5.5
Port Huron	156c	647	106	13	2.7
River Rouge	126	273	63	37	3.1
Royal Oak	518	943	231	94	3.0
Saginaw	280a	1,725	235	94	2.5
Wyandotte	...	...	...	...	..

a. Estimated. b. Incomplete. c. Buildings and contents only.
d. Insured loss only. e. Subject to change.

City	Total Loss in 1,000's	No. Alarms	Bldg. Fires	False Alarms	Bldg. Fires/ 1,000 Pop.
MINNESOTA					
Austin	179c	189	95	19	4.1
Duluth	415	1,577	562	75	5.1
Minneapolis	3,564	4,865	889	205	1.7
Rochester	67	559	305	93	6.8
St. Cloud	225c	411	139	27	4.0
St. Louis Park	69	725	210	3	4.9
St. Paul	1,893ae	4,494	1,467	426	4.7
Winona	99c	255	89	24	3.3
MISSISSIPPI					
Biloxi	226	295	81	19	2.2
Greenville	46c	552	195	6	6.5
Gulfport	...	428	81	18	3.7
Hattiesburg	166	560	122	24	4.2
Jackson	132	1,138	407	134	3.3
Laurel	57	373	130	15	5.2
Meridian	105c	573	205	45	4.0
Natchez	...	543	123	8	3.5
Vicksburg	193	475	204	38	5.8
MISSOURI					
Cape Girardeau	63	356	84	13	3.9
Columbia	58c	370	68	9	1.4
Hannibal	56	222	96	10	4.4
Independence	114	594	173	14	2.6
Jefferson City	12c	417	114	15	3.4
Joplin	96	803	234	37	5.8
Kansas City	2,810	5,776	2,259	408	4.1
St. Joseph	...	1,128	384	77	5.1
St. Louis	...	...	...	...	..
Sedalia	75	424	99	25	4.9
Springfield	194a	1,646	434	98	4.1
University City	17	885	62	25	1.1
Webster Grove	29c	341	80	6	2.7
MONTANA					
Billings	116c	487	194	10	3.5
Butte	...	...	...	...	..
Great Falls	79	627	128	56	3.3
Missoula	151a	369	120	23	4.8
NEBRASKA					
Grand Island	79	1,120	212	0	8.5
Hastings	20	251	71	5	3.1
Lincoln	670	1,385	363	35	3.7
Omaha	1,050	2,316	1,030	49	3.4
NEVADA					
Las Vegas	342	1,230	163	61	3.2
Reno	...	...	...	...	..
NEW HAMPSHIRE					
Concord	91cd	526	...	...	..
Manchester	341e	1,391	271	78	3.3
Nashua	488c	645	216	41	6.2
NEW JERSEY					
Atlantic City	970	1,030	425	163	6.9
Bayonne	...	976	165	94	1.9
Belleville	163	509	109	43	3.1
Bloomfield	70	641	228	36	4.7
Camden	521c	2,088	503	279	3.7
Clifton	367	959	111	26	1.2
East Orange	136cb	1,078	330	52	3.8
Elizabeth	838c	1,323	437	108	3.5
Englewood	...	418	190	51	7.3
Fair Lawn	43	274	74	...	3.1
Garfield	40	145	44	1	1.6
Hackensack	207c	576	80	32	2.4
Hillside	39	390	198	3	9.4
Hoboken	456	757	433	102	8.5
Irvington	104	438	171	28	2.9
Jersey City	1,280	3,882	1,308	280	4.3
Kearny	62	514	101	47	2.5
Linden	215	662	166	37	4.4
Long Branch	...	...	...	...	..
Maplewood	14	312	103	20	5.0
Montclair	222	663	340	16	7.4
Newark	2,904	6,624	3,042	802	7.0
New Brunsw'k	223	638	180	38	4.7
N. Bergen Twp	539	853	105	4	2.3
Nutley	23	474	18	25	0.7
Orange	158	701	181	63	4.6
Passaic	448c	903	46	52	0.8
Paterson	971c	2,081	835	176	5.8
Perth Amboy	229	578	180	28	4.4
Plainfield	80b	686	174	30	4.1
Rahway	452	435	121	8	5.7
Teaneck Twp.	170	868	247	11	6.2
Trenton	371	1,694	574	182	4.4
Union City	...	...	...	...	..
Union Twp.	196	811	258	11	5.2
W. New York	707c	750	142	16	3.6
Westfield	...	357	78	7	2.6
West Orange	...	588	150	25	4.7
NEW MEXICO					
Albuquerque	1,022	1,498	640	175	6.6
Roswell	379	495	241	24	9.4
Santa Fe	31	247	40	62	1.1
NEW YORK					
Albany	...	...	...	...	..
Amsterdam	186	444	93	15	2.9
Auburn	86ac	415	161	21	4.4
Binghamton	359	797	121	36	1.5
Buffalo	1,925	9,860	1,610	656	2.8
Cohoes	...	...	...	...	..
Elmira	313c	511	150	35	2.9
Endicott	8c	205	59	8	2.9
Freeport	...	...	...	...	..
Gloversville	136	291	70	34	3.0
Hempstead	142	562	145	31	4.3
Irondiqu't Twp.	...	...	...	...	..
Ithaca	163	216	56	9	1.9
Jamestown	226c	665	128	42	3.0
Kenmore	66	127	37	17	1.7
Kingston	23c	403	160	29	5.2

a. Estimated. b. Incomplete. c. Buildings and contents only.
d. Insured loss only. e. Subject to change.

City	Total Loss in 1,000's	No. Alarms	Bldg. Fires	False Alarms	Bldg. Fires/ 1,000 Pop.
NEW YORK (Continued)					
Lackawana	107	574	31	...	1.0
Lockport	257	247	115	22	4.3
Middletown	16	404	71	13	3.2
Mount Vernon	112	781	157	40	2.2
Newburgh	76	402	162	49	5.1
New Rochelle	225	945	334	31	4.5
New York	...	85,024	24,920	13,487	3.1
Niagara Falls	1,275	1,552	330	110	3.6
N. Tonawanda	58	389	76	9	2.4
Olean	89a	267	49	7	2.1
Oswego	203	279	99	49	4.4
Port Chester	...	...	...	...	..
Poughkeepsie	238	470	231	40	5.6
Rochester	386c	4,782	833	321	2.4
Rockville Ctr.	271	252	94	9	4.2
Rome	81	501	153	29	3.3
Schenectady	754	1,017	252	84	2.5
Syracuse	1,171	2,481	885	174	4.2
Troy	...	1,372	481	31	6.7
Utica	339c	972	350	66	3.4
Valley Stream	210	235	35	38	1.3
Watertown	70c	449	146	50	3.8
White Plains	294c	1,093	281	45	6.5
Yonkers	516c	2,527	603	179	3.4
NORTH CAROLINA					
Asheville	255c	778	57	71	1.1
Burlington	30	589	...	43	..
Charlotte	711	3,040	1,070	585	6.3
Durham	304c	1,043	522	66	5.9
Fayetteville	379	695	190	97	5.5
Gastonia	136	514	256	45	6.4
Goldsboro	40	1,209	286	35	11.0
Greensboro	286c	1,488	621	149	8.4
High Point	104	815	296	44	7.4
Raleigh	410	1,343	428	176	4.7
Rocky Mount	69c	416	101	23	3.1
Wilmington	...	...	...	...	..
Wilson	58c	465	216	91	7.0
Winston-Salem	559c	1,707	513	144	5.9
NORTH DAKOTA					
Fargo	172a	707	149	17	3.9
Grand Forks	154	283	171	15	4.5
Minot	61	375	102	5	3.3
OHIO					
Akron	864	2,942	743	352	2.4
Alliance	37	217	69	27	2.2
Ashtabula	83	387	90	14	3.5
Barberton	142	441	142	83	3.9
Canton	326c	945	249	182	2.2
Chillicothe	31	714	112	16	4.2
Cincinnati	838	6,581	2,118	760	4.2
Cleveland	3,233a	10,101	2,939	1,343	3.2
Cleveland Hts.	122	1,060	222	6	3.8
Columbus	446	6,107	2,689	283	7.2
Cuyahoga Falls	...	...	...	...	..
Dayton	313	7,793	769	420	2.7
East Cleveland	88	504	61	20	1.5
East Liverpool	62c	336	118	6	4.2
Elyria	...	...	...	...	..
Euclid	33	705	218	17	3.4
Findlay	41	556	198	2	6.6
Garfield Hgts.	57	217	74	3	3.4
Hamilton	70c	2,331	327	67	5.7
Lakewood	177	312	96	66	1.4
Lancaster	45	1,427	109	10	3.4
Lima	244	653	312	35	5.4
Lorain	173	748	119	31	1.9
Mansfield	157	756	248	45	5.7
Marion	84	824	167	19	4.4
Massillon	55	321	98	46	2.8
Middletown	255	727	244	47	5.4
Newark	31	578	171	34	5.0
Norwood	24	804	134	16	3.5
Parma	49	491	68	10	2.4
Portsmouth	201	940	177	76	4.8
Sandusky	127	709	85	16	2.8
Shaker Heights	304	495	329	34	9.1
Springfield	39	895	379	49	4.7
Steubenville	...	...	...	...	..
Toledo	1,447	2,748	909	431	3.0
Warren	161	762	128	44	2.0
Youngstown	423	2,056	473	190	2.6
Zanesville	435	424	224	36	5.6
OKLAHOMA					
Enid	194c	553	196	32	4.3
Lawton	187	885	324	24	6.5
Muskogee	82c	1,010	141	45	3.1
Norman	26c	272	80	6	2.0
Oklahoma City	2,080	6,876	1,187	373	3.3
Ponca City	42	501	155	11	5.0
Shawnee	54	416	81	4	2.7
Stillwater	23c	401	114	14	5.7
Tulsa	659	4,507	1,131	345	4.0
OREGON					
Eugene	...	...	...	...	..
Portland[1]	898	5,045	2,175	478	5.9
Salem	112	482	250	21	5.1
PENNSYLVANIA					
Aliquippa	19c	226	80	20	3.1
Allentown	497c	707	375	54	3.3
Altoona	421	717	172	87	2.3
Bethlehem	30	391	64	54	0.9
Butler	414c	329	130	3	5.7
Chelt'h'm Twp.	105	296	125	2	2.8
Chester	549c	838	265	117	3.5
Dunmore	...	...	...	...	..
Easton	406c	200	101	20	2.9
Erie	1,283	2,167	421	170	3.2
Harrisburg	86	788	333	89	3.8
Haverford Twp.	...	...	...	...	..
Hazleton	330	364	59	5	1.7
Johnstown	32	736	159	64	2.5

a. Estimated. c. Buildings and contents only.

1. Fiscal year ending 6/30/59.

City	Total Loss in 1,000's	No. Alarms	Bldg. Fires	False Alarms	Bldg. Fires/ 1,000 Pop.
PENNSYLVANIA (Continued)					
Kingston	4	121	46	7	1.7
Lancaster	102	584	284	49	4.1
Lebanon	30	172	81	2	2.6
Lower Merion T	599	1,016	300	0	6.1
McKeesport	343	633	197	147	3.7
Mt. Lebanon T	127	393	122	2	3.4
Nanticoke	...	...	...	...	..
New Castle	138c	653	390	35	7.1
New Kensing'n	65	188	55	46	2.0
Norristown	...	...	...	...	..
Philadelphia	5,016	35,974	4,843	4,004	2.3
Pittsburgh	...	...	...	...	..
Pottstown	56c	167	57	5	1.9
Pottsville	267c	144	42	10	1.8
Reading	371	619	252	25	2.3
Scranton	476c	1,140	317	98	2.3
Sharon	...	...	...	...	..
Uniontown	13	776	90	17	4.4
Upper Darby T	89	634	244	7	1.3
Washington	82	312	99	29	3.8
Wilkes-Barre	107	682	160	96	2.1
Wilkinsburg	18	186	83	34	2.4
Williamsport	87c	395	62	4	1.4
York	228c	389	179	58	3.0
RHODE ISLAND					
Central Falls	88c	406	78	34	3.1
Cranston	...	...	...	...	..
E. Providence	145	1,207	139	73	2.8
Newport	68	350	192	19	5.1
Pawtucket	307	2,610	372	211	4.4
Providence	913	3,578	364	543	1.6
Warwick Twp.	175	2,494	274	105	6.4
Woonsocket	263	783	248	116	4.9
SOUTH CAROLINA					
Charleston	215c	1,308	232	402	3.3
Columbia	258c	1,367	729	94	6.3
Greenville	240	1,172	420	151	6.7
Spartanburg	67	666	217	91	5.2
SOUTH DAKOTA					
Rapid City	717	827	99	13	2.3
Sioux Falls	233	648	160	13	3.1
TENNESSEE					
Chattanooga	609c	2,863	824	778	6.3
Jackson	52	400	...	...	..
Johnson City	34	559	108	14	2.8
Knoxville	214c	2,044	755	141	6.1
Memphis	1,765	7,202	2,378	201	4.7
Nashville	436c	2,474	1,138	417	6.6
TEXAS					
Abilene	820	1,182	458	85	9.7
Amarillo	470c	1,640	190	145	1.5
Austin	595c	2,437	391	37	2.1
Baytown	75a	245	79	1	3.5
Beaumont	617ac	2,567	1,437	74	1.5
Brownsville	14c	200	91	47	2.5
Brownwood	78a	1,216	23	154	1.2
Corpus Christi	229c	1,258	507	101	2.9
Dallas	3,456c	10,899	1,912	388	2.7
Denton	115c	464	110	9	3.7
El Paso	161c	2,920	598	244	4.6
Fort Worth	1,831	5,637	1,557	672	5.7
Galveston	...	...	...	...	..
Harlingen	...	...	...	...	..
Houston	3,853c	11,089	3,581	1,930	6.0
Laredo	55	679	101	52	2.0
Longview	156c	569	169	9	6.9
Lubbock	...	1,783	710	58	10.0
Marshall	174c	505	49	12	2.2
McAllen	124c	211	59	4	1.8
Midland	279c	735	252	63	4.3
Odessa	94ac	1,094	371	30	4.9
Orange	282c	324	81	32	2.5
Paris	636e	636	161	10	6.2
Pasadena	...	...	...	...	..
Port Arthur	402	574	78	97	1.4
San Angelo	389c	639	246	73	3.5
San Antonio	733	6,470	1,455	444	2.4
Sherman	...	...	...	...	..
Temple	161c	331	68	39	2.7
Texarkana	...	...	...	...	..
Tyler	252c	842	251	19	6.3
University Pk.	63	303	50	3	1.8
Waco	309c	1,071	421	15	3.8
Wichita Falls	...	...	...	...	..
UTAH					
Ogden	266	1,640	237	83	4.2
Provo City	43	362	98	13	2.4
Salt Lake City	1,382	2,460	638	114	2.9
VERMONT					
Burlington	...	...	...	...	..
VIRGINIA					
Alexandria	243c	5,117	505	113	5.3
Arlington Cty.	335	2,149	534	42	3.1
Charlottesville	96c	584	176	15	6.8
Danville	318	609	238	47	6.9
Hampton	277	1,119	152	84	2.5
Lynchburg	224e	963	208	97	4.4
Newport News	425	2,642	662	125	5.3
Norfolk	894	4,327	1,341	651	7.1
Petersburg	55	819	474	72	13.5
Portsmouth	239e	1,395	344	197	4.8
Richmond	1,267	3,767	1,158	378	4.8
Roanoke	210	1,637	182	275	2.0
WASHINGTON					
Bellingham	223	658	56	17	1.5
Bremerton	25	401	250	3	8.9
Everett	71c	686	182	58	4.8
Longview	163	232	122	30	6.0
Seattle	598c	5,398	1,076	360	2.3

a. Estimated. c. Buildings and contents only. e. Subject to change.

City	Total Loss in 1,000's	No. Alarms	Bldg. Fires	False Alarms	Bldg. Fires/ 1,000 Pop.
WASHINGTON (Continued)					
Spokane	522c	2,167	1,268	156	6.7
Tacoma	1,528	2,931	1,167	166	7.4
Vancouver	41	388	202	15	4.8
Walla Walla	356c	434	97	48	3.7
Yakima	151	657	296	14	6.6
WEST VIRGINIA					
Bluefield	...	...	...	...	..
Charleston	373	1,137	284	217	3.9
Clarksburg	161	286	196	8	5.9
Fairmont	94	805	107	2	3.7
Huntington	534	1,480	232	120	2.7
Morgantown	...	...	...	...	..
Parkersburg	166c	443	78	49	1.2
Weirton	30	185	37	6	1.2
Wheeling	87	1,980	183	47	3.1
WISCONSIN					
Appleton	77	559	201	22	5.9
Beloit	480	379	182	58	5.2
Eau Claire	25a	545	127	6	3.5
Fond du Lac	85	311	145	41	4.8
Green Bay	114	1,220	281	44	5.4
Janesville	237	243	35	16	1.4
Kenosha	224	1,118	274	37	5.0
La Crosse	217	718	293	29	5.6
Madison	216e	...	...	...	..
Manitowoc	118e	542	125	48	4.2
Milwaukee	2,463	10,849	1,709	470	2.3
Oshkosh	321a	634	180	37	3.8
Racine	157a	2,325	212	78	2.5
Sheboygan	149	574	443	30	9.8
Superior	563	815	287	46	7.6
Waukesha	27d	388	133	5	6.3
Wausau	377	486	104	18	3.2
Wauwatosa	190	859	182	20	3.3
West Allis	98	964	147	14	2.3
WYOMING					
Casper	94	527	213	27	6.3
Cheyenne	107	574	175	23	4.4

FIRE LOSSES, CANADIAN CITIES

City	Total Loss in 1,000's	No. Alarms	Bldg. Fires	False Alarms	Bldg. Fires/ 1,000 Pop.
ALBERTA					
Calgary	638	2,058	747	253	5.5
Edmonton	707	1,980	687	355	4.3
Lethbridge	79	291	89	23	3.9
BRITISH COLUMBIA					
Burnaby	188	968	147	11	2.5
New Westmin'r	131	417	75	43	2.5
Saanich	121	446	133	...	5.5
Vancouver	3,092e	5,826	1,753	196	4.5
Victoria	149	743	117	82	2.3
MANITOBA					
Brandon	38	261	141	20	6.7
St. Boniface	111	494	...	...	..
Winnipeg	461e	3,777	899	951	3.1
NEW BRUNSWICK					
Moncton	...	...	...	...	..
Saint John	240a	1,660	725	193	11.5
NOVA SCOTIA					
Glace Bay	133	164	96	6	3.4
Halifax	405	1,895	1,471	134	13.6
Sydney	495	846	540	144	19.1
ONTARIO					
Brantford	202c	474	69	1	1.9
Chatham	187	214	93	4	4.2
East York Twp.	54	439	35	10	5.1
Etobicoke	228	1,256	467	29	3.5
Fort William	35	565	264	17	8.6
Galt	86	367	190	...	7.0
Guelph	77	523	439	...	11.9
Hamilton	882	2,659	505	55	2.6
Kingston	216	767	248	30	4.9
Kitchener	1,093	553	139	5	3.2
London	781	1,101	283	30	2.7
Niagara Falls	93c	207	99	47	4.1
N. York Twp.	627a	1,961	723	32	2.9
Oshawa	94c	571	69	17	1.2
Ottawa	1,559	3,136	1,045	272	4.2
Peterboro	122c	801	505	...	11.0
Port Arthur	268	647	134	88	4.2
St. Catharines	129c	505	306	26	8.1
Sarnia	96c	471	65	...	1.9
Sault Ste. Marie	139c	472	56	25	1.4
Scarboro Twp.	976	1,528	298	61	1.6
Sudbury	97c	349	97	39	1.9
Timmins	472	637	66	40	2.4
Toronto	1,821c	7,643	2,810	1,004	4.2
Windsor	902	1,094	554	116	4.7
York Twp.	661	1,244	220	32	2.0
QUEBEC					
Chicoutimi	...	...	...	...	..
Hull	311	989	487	171	9.0
Jonquiere	...	...	...	...	..
Lachine	120	465	45	65	1.2
Montreal	7,805	15,797	2,827	4,968	2.0
Outremont	329	230	45	20	1.5
Quebec	863	2,432	266	752	1.1
Shawinigan Falls	...	...	...	...	..
Sherbrooke	456	758	34	136	0.6
Three Rivers	90	453	253	91	4.4
Verdun	278	923	557	92	7.0
Westmount	112c	480	156	45	5.4
SASKATCHEWAN					
Moose Jaw	75	340	43	48	1.7
Regina	695	1,002	299	144	4.3
Saskatoon	532c	877	368	175	6.9

a. Estimated. c. Buildings and contents only. d. Insured loss only.
e. Subject to change.

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A NATIONWIDE ORGANIZATION

Executive Office: 155 Sixth Avenue, New York 13, N. Y.

NEW OVERLY FIRE BARRIER

WITH PANIC HARDWARE

Successful U/L test ends illegal fire protection and safety compromises

On March 8 at precisely 3:58 PM, a new safety standard for the door manufacturing industry was set. With two 3-hour U/L tests for maximum performance—A, B, C, D and E labels—the Overly Fire Barrier, equipped with a Sargent panic bar actuated automatic top and bottom bolts and mortise lock device, now gives Fire Marshals and Fire Protection Engineers a fire barrier that is *both* panic proof and fire proof.

This new Overly product has completely eliminated the problem of labeling the inactive leaf of pairs of interior and exterior fire exit doors. Until now, every solution to this problem was more or less illegal and often highly questionable from a fire and life-safety standpoint.

The Old Problem

U/L required that the doors in every barrier carry an A, B, C, D or E label and be prepared for manually operated mortise top and bottom bolts on the inactive leaf and a mortise lock on the active leaf. With the bolts engaged, the inactive leaf was a killer from a panic standpoint. If the bolts were not engaged (a dangerous but customary practice) the door could easily pop open during a fire—it couldn't conform to fire prevention ordinances and building codes. The compromise was to get "labeled construction" doors (not really labeled) prepared for panic hardware or cheaper push-pull hardware in an attempt to provide some margin of panic protection and resistance to fire, smoke and heat.

In all of this, the Fire Marshal was left holding the bag. There was *no legal way* for him to enforce requirements for a fire barrier unit that would satisfy *both* fire safety and casualty and accident requirements.

The New Solution

The new Overly Fire Barrier tested with Sargent's new-design panic hardware puts an end to compromises. The fully labeled doors and frames assure proven protection against smoke or flame. New interior door channeling is specially designed for the new hardware—by utilizing a unique frame that contains the automatic top bolt for inactive leaf, manual throw bolts are completely eliminated. The doors are staunchly secured against fire and heat pressures, yet *both* leaves are easily released by the smallest school child under panic conditions.

This new Overly unit gives Fire Marshals and Fire Protection Engineers a product that will permit them to enforce fire and panic safety requirements in their areas. And, by assuring insurance rate credits for building owners, this new product encourages them to correct unsafe conditions.

How Overly Helps You

Overly has pioneered all of the modern advances in U/L approved door, frame, fire barrier and accessory products. Overly can provide you with literature, data, films and factory personnel available for consultation with groups.

To get complete details on the new Overly Fire Barrier with approved panic bolt hardware—and the only complete line of U/L approved hollow metal products—write: Overly Manufacturing Company, Greensburg, Pennsylvania.

Overly

MANUFACTURING COMPANY

GREENSBURG, PENNSYLVANIA ST. LOUIS 19, MISSOURI LOS ANGELES 39, CALIFORNIA

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DALLAS, TEXAS	**SMITH DETECTIVE AGENCY & NIGHTWATCH SERVICE, INC.** 610 N. Akard Street
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HONOLULU, HAWAII	**CENTRAL ALARM COMPANY, LTD.** 1755 Kapiolani Boulevard
HOUSTON, TEXAS	**McCANE-SONDOCK ALARM SYSTEMS** 1612 Austin Street
LOS ANGELES, CALIF.	**MORSE SIGNAL DEVICES OF CALIFORNIA** 211 So. LaBrea Avenue
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NEWARK, NEW JERSEY	**NEWARK DISTRICT TELEGRAPH CO.** 372 Plane Street
NEW YORK, NEW YORK	**CENTRAL STATION SIGNALS, INC.** 53 West 23rd Street
PEORIA, ILLINOIS	**PROTECTION ALARMS, INCORPORATED** 725 West Main Street
PHILADELPHIA, PENNA.	**OWL PROTECTIVE CO., INC.** 120 No. Camac Street
PHOENIX, ARIZONA	**CENTRAL BURGLAR ALARM COMPANY** 210 West Adams Street
ST. LOUIS, MISSOURI	**POTTER ELECTRIC SIGNAL & MFG. CO., INC.** 1211 Pine Street
SAN FRANCISCO, CALIF.	**PACIFIC FIRE EXTINGUISHER CO.** **AMERICAN BURGLAR ALARM DIVISION** 165 Jessie Street
SO. MINNEAPOLIS, MINN.	**AUTOMATIC ALARM CORP.** 2404 Lyndale Avenue
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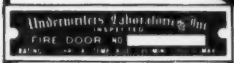

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—*and they're ALL* by "CELOTEX"

Here are some examples of tile used in "Ceilings by Celotex" that meet building code requirements for incombustibility.

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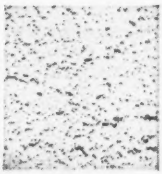
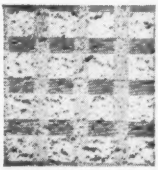
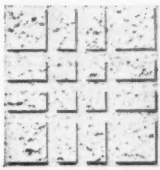


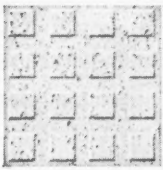
CELOTONE®



"DESIGN" CELOTONE® Plaid



"DESIGN" CELOTONE® Monarch



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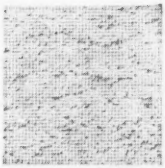

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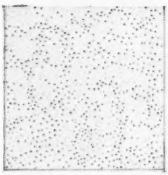
PERFORATED MINERAL FIBER TILE



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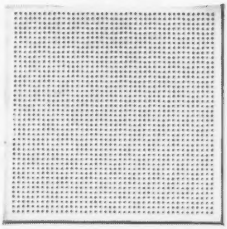

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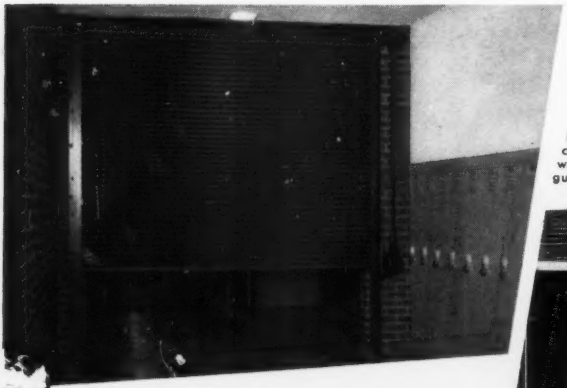

Kinnear Rolling Fire Doors can be mounted on face of wall, as at left, or with jamb guides built into wall.

A Two-Way Check on Fire Doors *is suggested by* Kinnear

1. Check Fire Doors you NOW HAVE.

2. Check for Fire Doors you MAY NEED.

Make sure building changes due to repairs, new equipment, painting, resurfacing, or any other factor, has not made existing fire doors inoperable. They should be checked at least once or twice a year.

(One of the many advantages of Kinnear (AKBAR) Rolling Fire Doors is that they make periodic testing and resetting easy.)

But whether you're checking your present fire doors or the need for new ones, make sure they have the features Kinnear offers in its exclusive AKBAR Steel Rolling Fire Doors.

- **Automatic release in case of fire.**
- **Positive, spring-activated start.**
- **Closing speed safety-controlled.**
- **Operable after automatic closure.**
- **Easily reset after periodic testing.**
- **Curtain can't drop below closed position.**
- **Can be operable in daily service use.**
- **Labeled by Underwriters Laboratories, Inc.**

Kinnear AKBAR Steel Rolling Fire Doors are labeled by Underwriters Laboratories, Inc., and are built to fit any opening within U/L limits. *Write today for complete details.*

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Saving Ways in Doorways

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FACTORIES:
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When life is measured in minutes

It only takes a minute — for dense clouds to billow from windows . . . winds to whip flames into a roaring inferno . . . and tragedy to strike — *all needlessly!* For in those same minutes a Rockwood Sprinkler System can give you priceless protection from the fire.

By actual records of the National Fire Protection Association there has never been a loss of life in a completely sprinklered school. Sprinkler systems have been effective either in completely extinguishing the fire or holding it in check. These are facts.

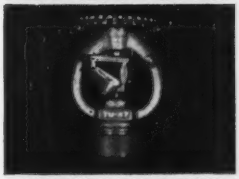
And facts are what insurance companies base their rates upon — that's why *you can save up to 80% on your fire insurance policy when your property is protected by sprinklers.* And remember, you can have a system installed on a deferred payment plan. Your insurance savings can pay a substantial part of the cost of the system.

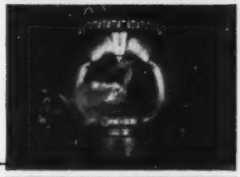
The Rockwood Sprinkler Company has a staff of scientifically trained fire-fighting experts that will be happy to meet you or your committee to give full information and advice on how an engineered sprinkler system can save lives and property. Call the Rockwood fire engineer nearest you.

ROCKWOOD SPRINKLER COMPANY

Engineers Water . . . to Cut Fire Losses

Tested and listed by Underwriters' Laboratories, Inc.





One-tenth of a second after the solder melts on this Rockwood Sprinkler head, water sprays out to extinguish or control the fire — *all automatically!*

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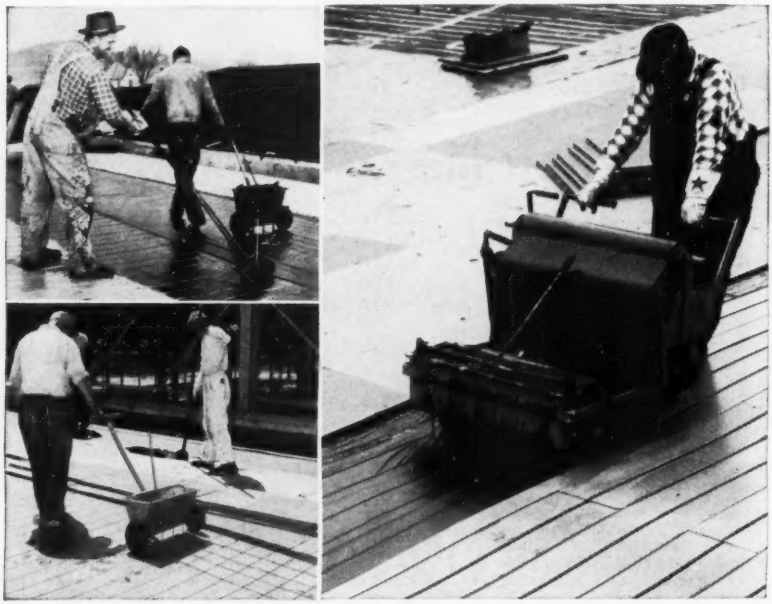

Pictures. (Right.) Lexsuco Applicator applies vapor barrier and adhesive for large jobs in a 3 in 1 operation. (Top left.) For smaller jobs, the semi-mechanical method is used to apply vapor barrier and adhesive with Spreader and Roller Coater. (Bottom left.) Lexsuco Spreader applies adhesive to secure insulation.

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Engineered Applications Save Time and Money

LEXSUCO'S engineered application methods cut labor costs and speed up work in applying Lexsuco Fire-Retardant Roof Constructions on large or small jobs. Lexsuco products are reliable and job proven.

Remember, with or without a vapor barrier, Lexsuco Roof Constructions provide assured fire protection as tested and accepted by Factory Mutual Engineering Division and Underwriters' Laboratories, Inc. Write us for complete information or call your Lexsuco Representative.

- Assured Fire Protection
- More for Your Roofing Dollar
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- Better Roof Construction

LEXSUCO INC

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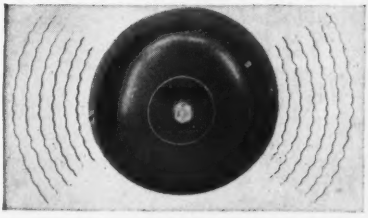
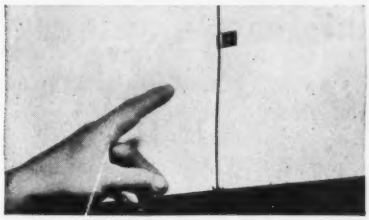
Pioneers in Fire-Resistant Roof Constructions

FIRE ALARM!



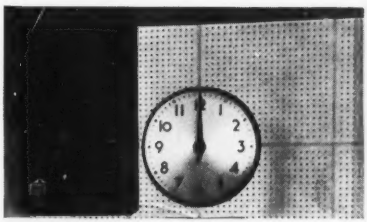
1. Save priceless lives, protect valuable buildings with the Kidde Atmo Fire Detecting and Alarm System!

2. This automatic detecting and warning system sounds an alarm instantly at the *first* hot breath of fire!



3. Using rate-of-temperature-rise tubing as a sensing element, the system works without outside power!

4. Kidde's Atmo system can sound alarm at fire area, outside the building or at local fire department station!



5. Kidde's Atmo system also gives fire location at a panel near any manned telephone switchboard!

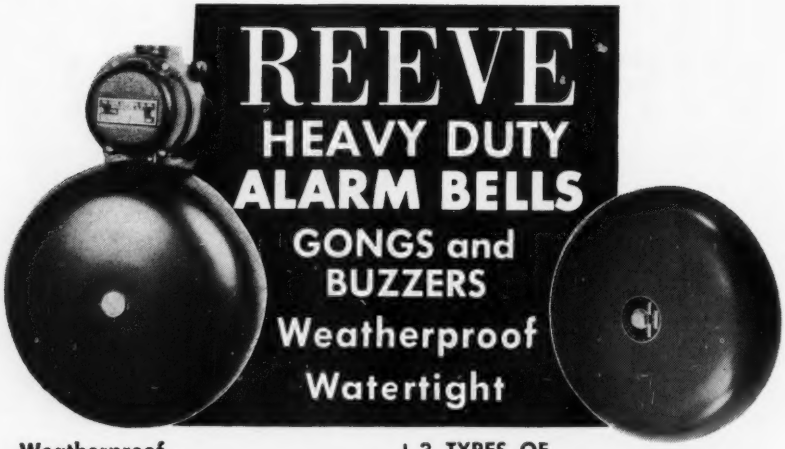
Kidde Atmo

KIDDE ULTRASONIC & DETECTION ALARMS, INC.

451 Brighton Road, Clifton, N. J.

A Subsidiary of
Walter Kidde & Company, Inc.
Belleville 9, N. J.

FOR fast, dependable fire detection and warning, install a Kidde Atmo Fire Alarm System. Ideal where life protection and early fire warning is essential, the Kidde Atmo system can also close doors, shut off fans, motors, blowers, is automatically re-setting after use or test. Get more information! Write today and ask for Kidde's Atmo Alarm Systems booklet!



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Weatherproof
Watertight

Weatherproof —
Sizes 3", 4", 6", 8", 10", 12"
DC—6—220 V. • AC—12—220 V.

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60 Cycles, 110—220 Volt, 25 Cycles

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Sizes 6", 8", 10". Cast aluminum housing
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Voltages are the same as Neck Type

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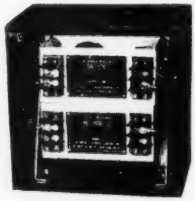
AUTOMATIC BATTERY CHARGER, High and Low Current

The unit is designed for use on any storage batteries not subject to heavy drains. It will trickle charge the battery indefinitely because of its automatically decreasing rate of charge.

For use with six cells (12 volts). Automatically controlled by saturable reactor. Continuous output one ampere. 22.5 watts, 118 volts, 60 cycles. 3% Regulation. 9" x 9" x 6" — 14 B & S gauge steel wall cabinet. 15¼ lbs. U.L. Approved. No moving parts.

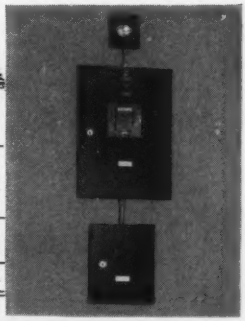


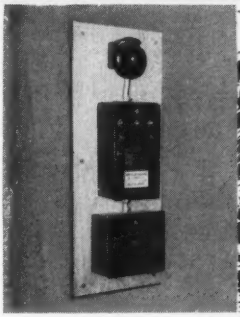
MODEL BC-12

Manufacturers of a complete line of

CENTRAL OFFICE and LOCAL FIRE ALARM DEVICES
• automatic alarm devices • sprinkler alarm and supervisory devices • burglar alarm devices and accessories. DYNALARM (sound detection for both reverberant and non-reverberant vaults).

THE REEVE ELECTRICAL CO., Inc.
132 Lafayette Street, New York 13, New York





Autocall® REMOTE STATION SYSTEM

provides 24-hour-a-day automatic fire protection ...instantly summons the fire department

This is the kind of protection your schools, hospitals, public buildings and industrial plants need... constant protection even when premises are unoccupied, no delay in calling the fire department, and foolproof operation with no chance for false alarms.

Complete electrical supervision warns of power failures and circuit faults at both the fire station and protected property. It also insures proper restored operation after trouble or alarm signals have been silenced.

This is the most reliable fire protection you can recommend... and the added safeguards cost the property owner no more than many conventional systems.

GET YOUR COPY NOW!

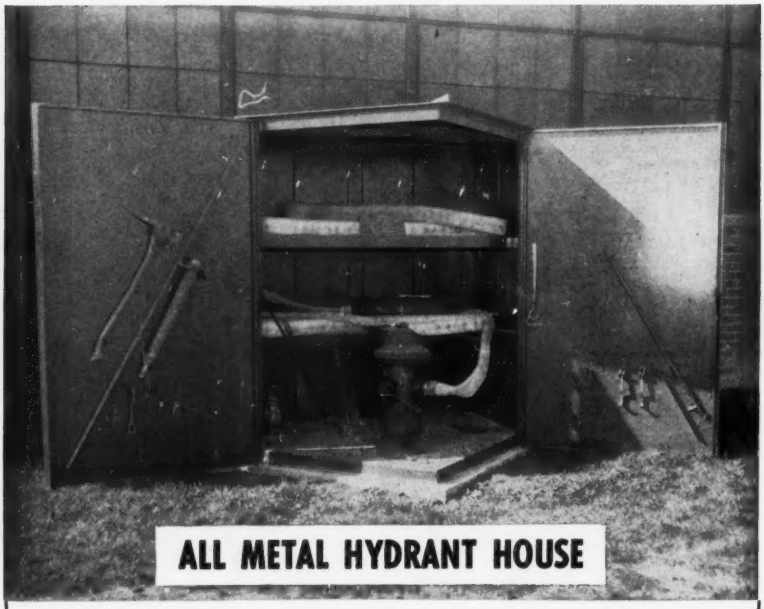
Write for Autocall's Remote Fire *Alarm brochure.* Gives you the needed information to help your people plan the finest in fire protection systems.

UL FM

Autocall®

FIRE PROTECTION SYSTEMS SINCE 1908

THE AUTOCALL COMPANY • SHELBY, OHIO • SALES OFFICES IN PRINCIPAL CITIES



ALL METAL HYDRANT HOUSE

— FACTORY MUTUALS APPROVED —

Many Architects and Engineers are specifying the Model 60 or 60-L ALL-METAL Hydrant House on new jobs and recommend their use for replacement of existing wooden houses as they wear out.

The advantage of a Hydrant House is that it protects the hose and hydrant during inclement weather when sleet or snow cause heavy icing. The hose is coupled and ready at any hour of the day or night. All metal houses are weathertight and rat proof — will not warp or dry out. Eight (8) Louvers are stamped in side panels and shelves are perforated for ventilation. Finished weights — 565 lbs. and 650 lbs.

Houses are shipped from stock, knocked down. Roof, base, shelves, doors and panels are completely prefabricated of **galvanized iron with zinc plated hardware. Hinges are brass pinned.** All bolts for assembly are furnished. No cutting, drilling or welding is required in the field, thereby reducing the installation time to a minimum. Instructions are furnished for a simplified concrete foundation slab.

Manufactured by

VAN LOON INDUSTRIES, INC.

ENGINEERING & METAL FABRICATING

3409 East McNichols Road Detroit 12, Michigan

TWinbrook 3-4460 TWinbrook 3-4461

PREFABRICATED METAL HOUSES FOR HOSE CARTS

"Worthy of Your Confidence!"

Reliable Automatic Sprinkler Devices have been protecting life and property for more than 35 years. The practical design and rugged construction are universally approved and accepted by all Fire Insurance and Governmental Authorities. Reliable Automatic Sprinklers effect maximum reductions in fire insurance premiums.

Reliable's complete line provides a wide selection of Sprinkler Devices to meet any condition, including: Automatic and Open Sprinklers, Alarm Valves, Dry Pipe Valves, Accelerators, Electric Alarm Switches, Water Motors, and all Sprinkler System Accessories.

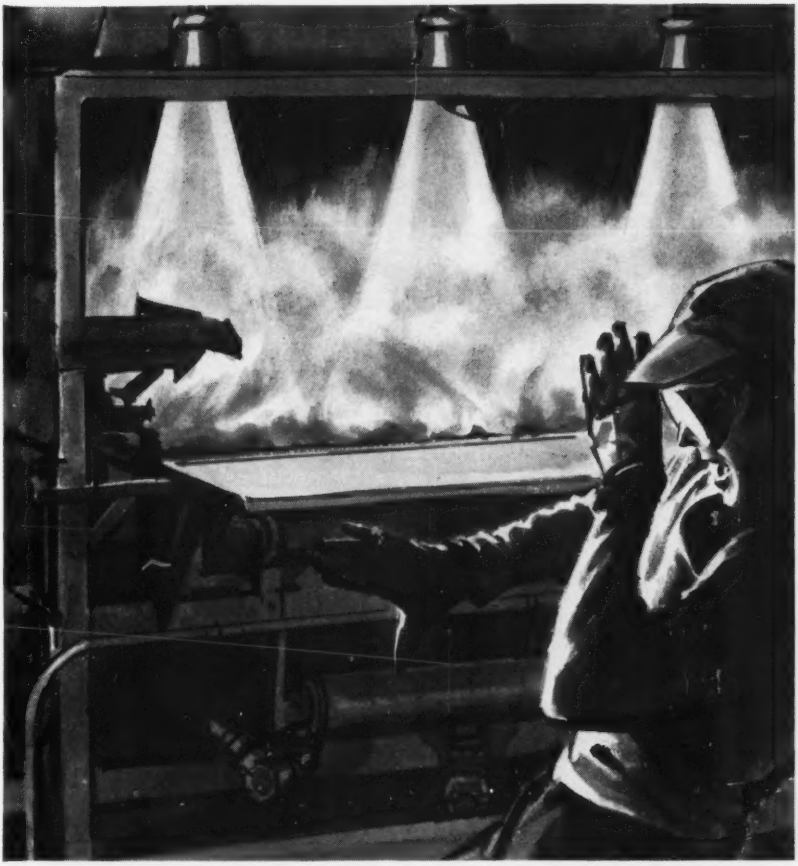
Experienced Reliable Licensees are located throughout the United States, Canada, and foreign countries. They are expertly qualified to design and install a Reliable Sprinkler System for your specific needs.

THE RELIABLE AUTOMATIC SPRINKLER CO. INC.
Manufactured and Distributed by
[illegible] STREET, MOUNT VERNON, N. Y.

"THE SAFE WAY OUT!"

● Since originating the fire and panic exit device in 1908, Von Duprin has consistently pioneered advances in design, use of new materials and a line of auxiliary items to provide "safe exit" for any building, any condition.

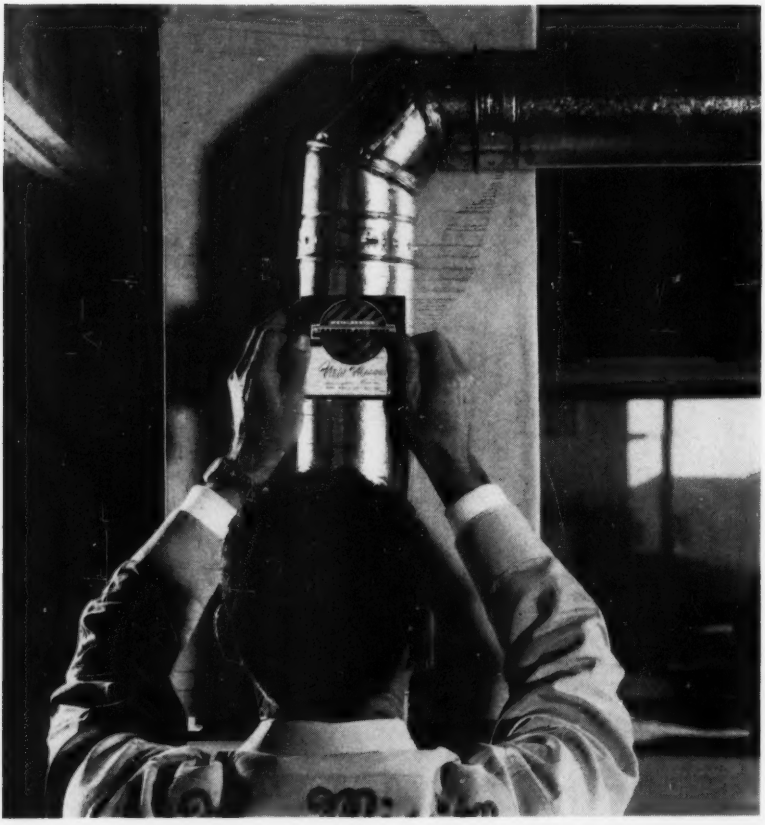
VONNEGUT HARDWARE CO.
VON DUPRIN DIVISION • INDIANAPOLIS, INDIANA



Instant bankruptcy! In a flash, fire can put you out of business. Protect dangerous flammable liquid hazards (like the coater shown above) with a *fully-automatic* Kidde carbon dioxide extinguishing system. Approved by U.L. and F.M., Kidde systems smother fire in seconds, leave no mess, turn off power and sound an alarm . . . get you back in production fast! Kidde's 35 years' experience can help you protect *any* hazard . . . write today and find out how.

Kidde (K Kidde)

Industrial and Marine Division
Walter Kidde & Company, Inc.
451 Main St., Belleville 9, N. J.
Walter Kidde & Company of Canada Ltd.
Montreal — Toronto — Vancouver



You Can Tell A Metalbestos Man

By the "safety system" he uses!

Every man who installs Metalbestos gas venting is privileged to leave that "Safety System" Seal. It tells you he put in vent pipe whose design and installation were determined by industry-endorsed scientific principles. It signifies safe heating for the life of the home.

See your local Metalbestos representative or write Dept. I

Available Only From Metalbestos
Color Slide Film ("Heat in Harness") • Venting Service Schools • Vent Installation Handbook • "Safety System" Gas Vent Tables • Gas Vent Service Bulletins • Safety System Seals • Sales, Product & Technical Literature • Ad & Article Reprints • Direct Mail & Display Materials.

METALBESTOS
DIVISION

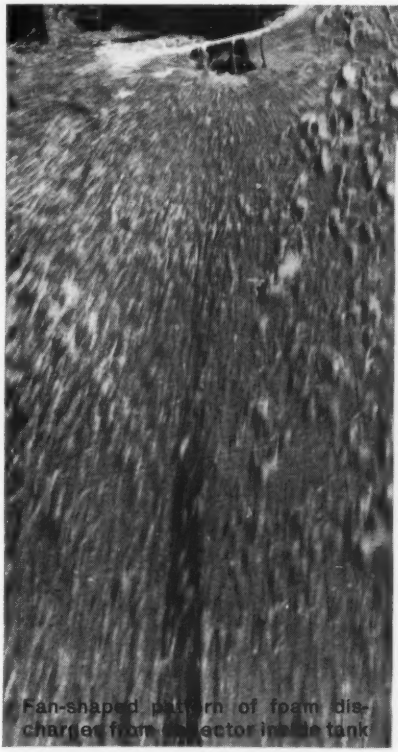
WILLIAM WALLACE COMPANY, BELMONT, CALIFORNIA
Manufacturing Plants in Belmont, California • Logan, Ohio

do your FOAM CHAMBERS measure up to these standards?

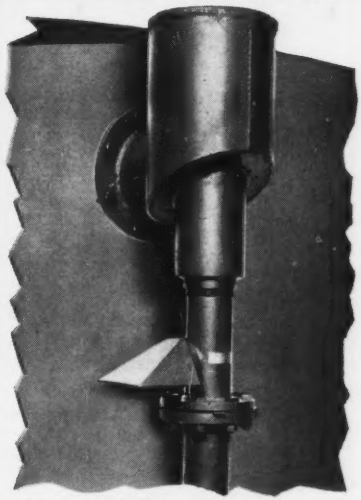
1. Are they vertical rather than horizontal, so that they won't snap off if the tank explodes? ☐ Yes ☐ No
2. Are they truly compact in design . . . reducing labor costs during installation? ☐ Yes ☐ No
3. Do they permit filling tanks to the top angle without immersing the glass diaphragm and running the consequent risk of loss of product in case of broken glass? ☐ Yes ☐ No
4. Do the deflectors spread foam in a fan-shape pattern to reduce submergence and turbulence? ☐ Yes ☐ No
5. Do they use positive pressure to break the glass diaphragm, instead of merely relying on water velocity? ☐ Yes ☐ No
6. Do they require minimum maintenance? ☐ Yes ☐ No

If you can answer YES in all cases, you already have National Aer-O-Foam Chambers. If not, you need them! For full information, write for Booklet E.

NATIONAL FOAM SYSTEM, INC.
West Chester, Pa.



Fan-shaped pattern of foam discharged from deflector inside tank

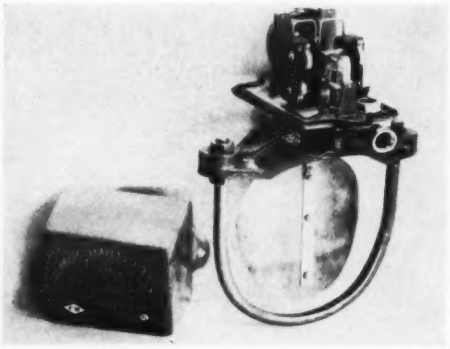


Type MCS Foam Chamber, with Selective Orifice Foam Maker

CENTRAL STATION SIGNALS, INC.

Manufacturers of all kinds of approved devices used in Central Station Systems or Class 'A' or Class 'B' Proprietary Fire Alarm Systems, either automatic or manual.

53 WEST 23rd STREET . . . . . NEW YORK 10, N. Y.



Model PRS-1

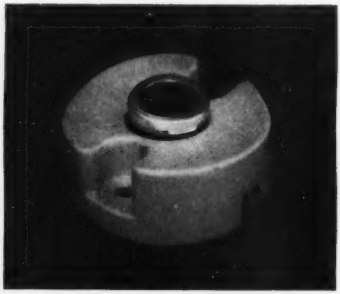
Sprinkler Waterflow Alarm

This device is approved by Factory Mutual Laboratories and Underwriters' Laboratories, Inc.

- This device is also made as Model PRT-1, a coded waterflow transmitter.

5-inch size shown above. To install simply drill 2-inch hole in pipe.

- Also made in explosion proof models.
- Made in all sizes from 2½" to 8".
- Has instantly recycling pneumatic retarding device, preventing false alarms.
- Has enclosed electrical contacts for any voltage not exceeding 15 amp. 125 volts, A.C. and ½ amp. 125 volts, D.C. Operates on all water pressures or surges.



Size is 1⅝" x ⅝"

Tempo-Set Model A Fire Detector

Underwriters' Laboratories, Inc. Approved.

- Self restoring and can be heat tested.
- Electrical contacts are silver or gold and are enclosed.
- Very reasonable price.

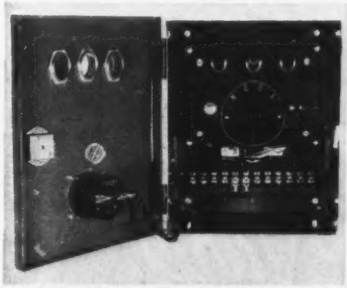
- Tempo-set Model A is approved in either open or closed circuit and the temperature ratings are 135 and 200 degrees.
- Approved maximum distance between thermostats on smooth ceilings: 20 feet.
- Electric ratings are 125 volts 1 ampere, A.C. or 24 volts 0.5 ampere D.C. or less.

CENTRAL STATION SIGNALS, INC.

53 WEST 23rd STREET . . . . NEW YORK 10, N.Y.

Proprietary & Remote Panels For Fire Headquarters

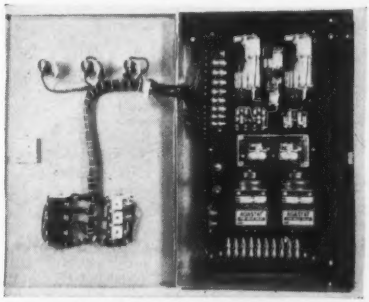
This Fire Headquarters Unit is designed to be used primarily for the receipt of signals at a remote station when actuated by a local alarm unit in the protected premises. It is electrically supervised and will give a trouble signal in case of open and ground and will also receive an alarm under these conditions. This panel is made for 12 or 24 volt D.C. operation.



Local Non-Coded Fire Headquarters Unit

Automatic McCulloh Class A Proprietary Panel

This single circuit panel is mounted in a red metal cabinet 18 x 12 x 6 inches, with switches and lights. This panel operates on the well known McCulloh principle. Signals are ordinarily received over a closed supervised circuit. With the McCulloh principle, a signal will be received over the circuit even though a single break or a single ground, or both, has occurred on the signaling circuit. This panel automatically adjusts the circuit for these fault conditions instead of the customary switches which are adjusted manually. A break or ground will be immediately indicated by a light and audible signal. The relays used in this panel are very sensitive and will receive signals from a considerable distance on No. 26 gauge wire and longer distances from heavier gauge wire. This panel operates on 24 or 48 volts of D.C. and requires a battery and rectifier for its operation.



Model ACP Single Circuit

Manual fire alarm boxes, automatic sprinkler alarm transmitters, automatic fire alarm, watchman supervisory signals, etc. can be received and recorded on this panel.

BOTH OF THE ABOVE PANELS ARE "APPROVED" BY UNDERWRITERS' LABORATORIES, INC.

LOW COST
FIRE & EXPLOSION PROTECTION

for FLAMMABLE LIQUID STORAGE

WITH "Varec"
FLAME ARRESTERS
in combination with your
VENT VALVES

Flame Arrester Unit
listed by
UNDERWRITERS' LABORATORIES
Approved by Associated Factory Mutuals
Laboratories and other governing agencies.

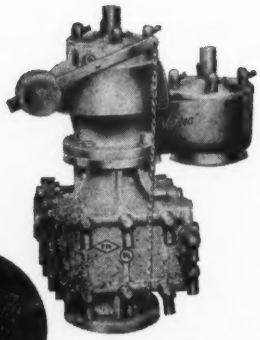


Fig. No. 5800A
Conservation Vent Unit consisting of VAREC Vent VALVE in combination with VAREC FLAME ARRESTER

You can rely on VAREC CONSERVATION VENT UNITS to provide full fire protection on your liquid storage at low cost. Protection against entry of flame through the venting device is certain when Varec Flame Arresters are used. Protection against excessive pressure or vacuum is assured by the VAREC VENT VALVE. The combination unit gives you complete security against major hazards of flammable liquid storage. Average installation costs 1/10th of 1% of your investment in tank and products. Secure full details from your VAREC Representative or write factory.

NF-3

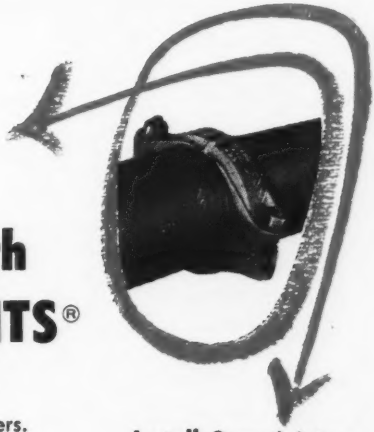
"Varec"

THE VAPOR RECOVERY SYSTEMS COMPANY

COMPTON, CALIFORNIA, U. S. A.

Cable Address: VAREC COMPTON USA
(All Codes)

Couple Pipe the Easy, Low Cost Way with G-B GRUVAJOINTS®



Now you can save up to 25% when connecting pipe for bulk runs and risers. Yes, contractors are saving money every day when they use new lightweight Gruvajoints. There's no flanging, no threading, no welding, and there's no need for heavy chain tongs or pipe wrenches. Gruvajoints are truly the modern way to couple pipe. Write today for free illustrated brochure on G-B Pipe Coupling Products. Gruvajoints are now available in 2", 2½", 3½", 4", 5", 6" and 8" sizes. ROLAGRIPS® ALSO AVAILABLE FOR PLAIN-END PIPE CONNECTIONS.

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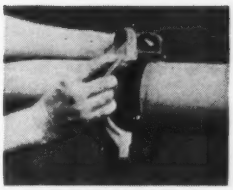
Underwriters' Laboratories, Inc.
File EX 1741A and B

APPROVED by
Factory Mutual Engineering Division
Report Serial No. 13097

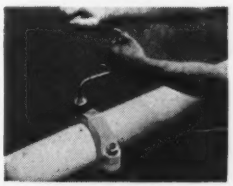
GUSTIN-BACON
manufacturing company
266 W. 10th St. Kansas City, Missouri

Install Gruvajoints in three easy steps

Grease gasket and center over pipe ends.



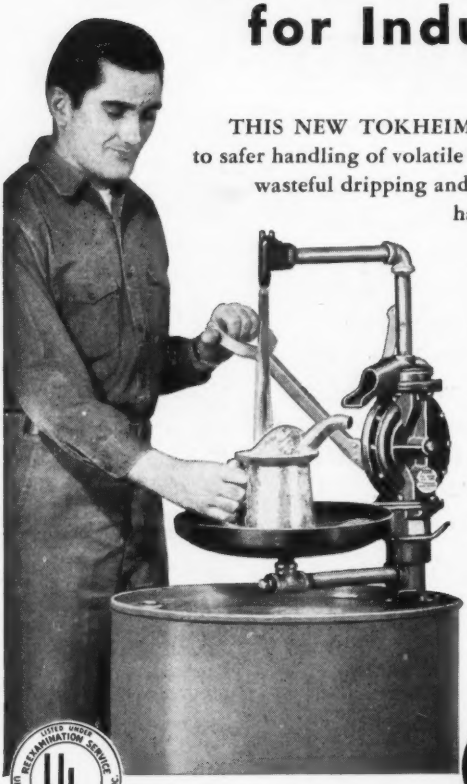
Lay housing halves into grooves and insert bolts.



Tighten the two nuts equally.

SAFER

liquid handling for Industry



THIS NEW TOKHEIM HAND PUMP contributes to safer handling of volatile liquids wherever used. Stops wasteful dripping and slippery floors. Reduces fire hazard and accidents common to other methods of liquid transfer. Approved for handling petroleum liquids —ideal for many others. Available in 22 different models for 'most any use— from pipe lines to drums, or underground tanks, with hose or spout outlets. Order from your dealer, your oil company, or your Tokheim representative.

Write factory for literature.

LISTED UNDER RE-EXAMINATION SERVICE UL UNDERWRITERS' LABORATORIES, INC.

QUALITY TOKHEIM HIGH VACUUM HAND PUMPS

General Products Division

TOKHEIM CORPORATION

DESIGNERS AND BUILDERS OF SUPERIOR EQUIPMENT SINCE 1901

1686 WABASH AVENUE FORT WAYNE, INDIANA

Subsidiaries: Tokheim International, A. G., Lucerne, Switzerland; GenPro Inc., Shelbyville, Indiana; Tokheim of Canada, Ltd., Toronto, Ontario

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WAMSUTTA/PACIFIC INDUSTRIAL FABRICS, 1430 Broadway, New York 18, N.Y.

Kuhns

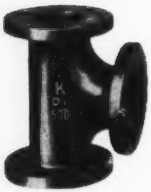
NOW... ductile iron fittings

For Sprinkler Systems

Kuhns ductile iron pipe fittings—the newest development in piping—provide an extra margin of operating safety for sprinklers, high pressure lines and other vital piping systems. High structural strength and resistance to thermal shock help these fittings prevent leakage caused by vibration, temperature changes or misalignment.

"K" Pipe Lock Couplings

Listed for 800 psi by Underwriters' Laboratories, Inc., these couplings have a safety factor of five times the UL listing for 2½" through 6" and four times UL listing for 8". Sizes: 2½" through 8". Look for the "800 D" on each.



"K" Flanges and Flanged Fittings

Pressure rating, 500 psi by Underwriters' Laboratories, Inc. for elbows, base elbows, 45° elbows, side outlet elbows, tees, side outlet tees, and reducers in straight and reducing sizes. Flat faced flanges standard. Extra heavy flange dimensions and raised faces available. Look for the "DI 500" on each.

Complete range of sizes through 12".

"K" Screwed Fittings *

Pressure ratings listed by Underwriters' Laboratories, Inc.

STEAM AND OIL AT 550°F

¼" to 3".....300 lbs.

LIQUID AND GAS AT 150°F

¼" to 1".....2000 lbs.

1¼" to 2".....1500 lbs.

2½" to 3".....1000 lbs.

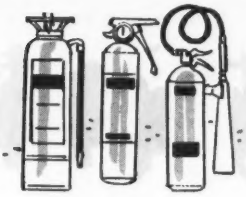
**Ductile iron fittings are available in any size in Kuhns complete cast iron line, ¼" through 12".*

Note: These fittings are excellent for liquefied petroleum gas systems. Look for the "DI 300" on each.

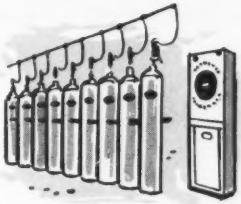
Send for our catalog or contact your wholesaler.

THE KUHNS BROTHERS CO.

1800 McCALL STREET, DAYTON, OHIO

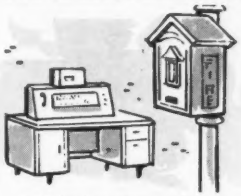


Fyr-Fyter, Pyrene-C-O-Two Buffalo fire extinguishers

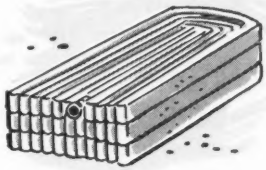


C-O-Two carbon dioxide, dry chemical, foam systems

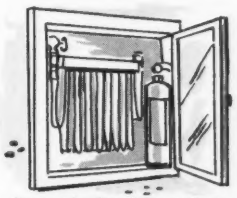
Globe sprinkler systems



Fyr-Fyter fire alarm systems



Municipal, industrial fire hose



Hose and extinguisher cabinets

Wooster brass fire equipment

Fire department supplies

complete fire protection from Fyr-Fyter

Complete fire protection requires many different kinds of equipment. Fyr-Fyter can supply all the dependable, high-quality products and services you'll need!

You also surely need the deep knowledge and experience acquired by Fyr-Fyter representatives in industrial, commercial, institutional, municipal and household fields. These men are uniquely qualified to survey, analyze and recommend the proper equipment to guard every fire risk.

To contact the representative nearest you, look in the yellow pages under "Fire Protection Equipment" or write to: The Fyr-Fyter Company, 221 Crane Street, Dayton 1, Ohio.

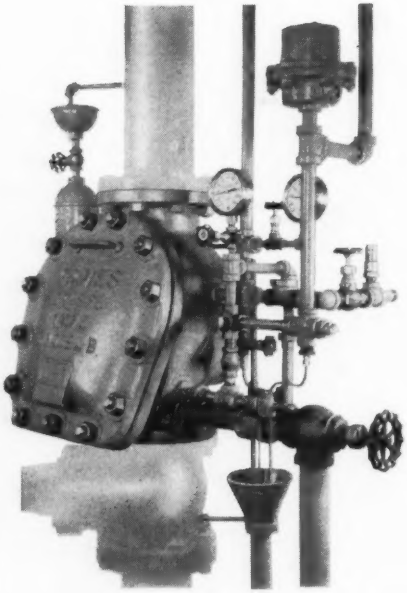
Fyr-Fyter

Representatives and Distributors in all principal cities.

NEW IMPROVED

GRIMES **MODEL B**

DRY PIPE VALVE



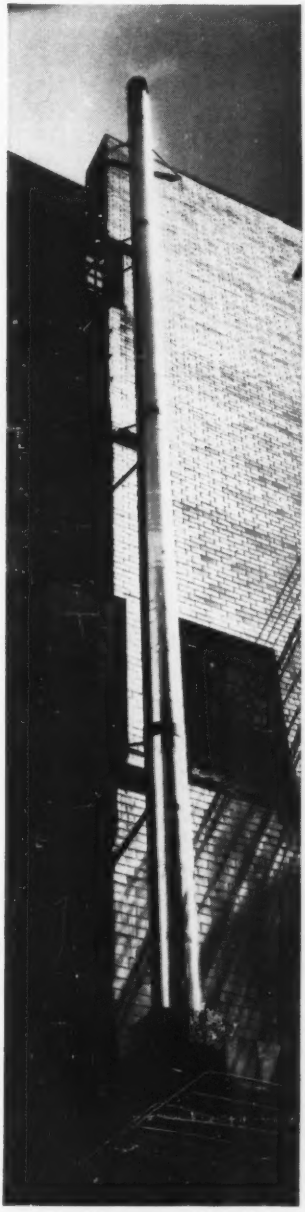
Another new GRIMES device which has been designed for functional efficiency and simplicity in maintenance. The full size cover plate makes the entire interior of the valve accessible. Cleaning and re-setting takes but a few minutes. If maintenance is your responsibility specify "Grimes". For more information write Raisler today.

GRIMES DEVICES ARE APPROVED BY ALL INSURANCE INTERESTS

RAISLER
SPRINKLER DIVISION

RAISLER CORPORATION, 750 Third Ave., New York 17, N.Y.
Licensees in all principal cities in the United States and Canada

VAN-PACKER
MODEL HT
SMOKESTACK now listed by UNDERWRITERS' LABORATORIES



Wherever you see a Van-Packer Model HT Prefabricated Refractory Smokestack specified for boilers, furnaces and incinerators, you can be sure it will give safe and reliable service. Van-Packer Model HT Smokestacks meet the high standards required to earn listing by Underwriters' Laboratories, Inc.

Write for data on Underwriters' Laboratories listing of Van-Packer Model HT Smokestack

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Division of:

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Manufacturers of Diversified Products for Home and Industry

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STARGARD

GIVES YOU MORE — FOUR WAYS

UPRIGHT SPRAY SPRINKLER

PENDENT SPRAY SPRINKLER

APPROVED BY
FACTORY MUTUAL LABORATORIES

SIDEWALL SPRINKLER

LISTED BY
UNDERWRITERS' LABORATORIES, Inc.

SMALL ORIFICE SPRINKLER
(With Identifying Pintle)

1 **SUPERIOR PROTECTION** . . . due to more efficient water distribution. Proven by tests under actual fire conditions for all classes of hazards.

2 **MORE EFFECTIVE USE OF LESS WATER** . . . because wider distribution and break-up of the water discharged provides greater cooling and extinguishment.

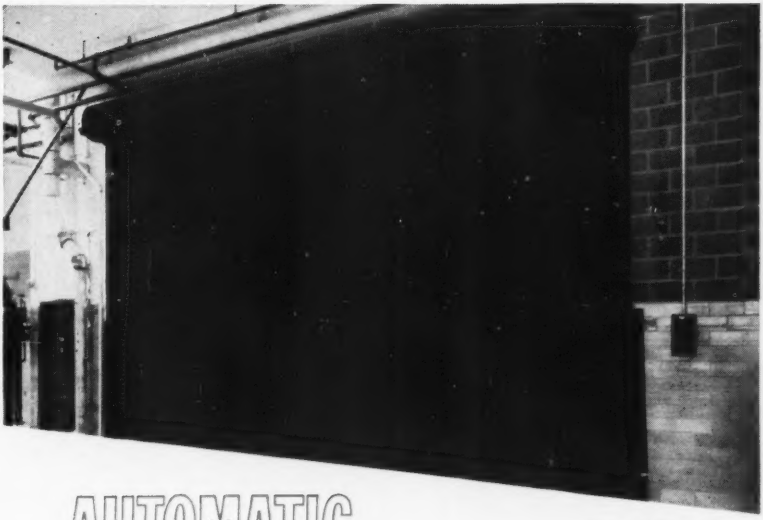
3 **CEILING PROTECTION BY COOLING — NOT WETTING** . . . All the water goes onto the fire. The break-up of water results in complete cooling and control of flammable vapors.

4 **MORE FIRE CONTROL WITH FEWER SPRINKLERS** . . . because ceiling temperatures are kept lower, fewer sprinklers open. Immediate water saturation of the fire area prevents the spread of fire. Hot gases become impotent in the cooled atmosphere.

STAR SPRINKLER CORPORATION

Westmoreland & Collins Sts., Phila. 34, Pa.

Licensees in principal cities of the United States and Canada



AUTOMATIC

ROLLING-STEEL FIRE DOORS

PREFERRED FOR USABILITY . . . SPECIFIED FOR PROTECTION

ABOVE: A Mahon Rolling Steel Fire Door Serves a dual purpose—an internal dividing wall and an automatic fire barrier. BELOW: Window shutters too, are Mahon—supplied in sizes to your need for full fire protection.

Automatic Fire Doors and Shutters from Mahon have been carefully engineered to offer you many advantages of safety and function. They are operated manually or mechanically in everyday use—automatically closing if fire breaks out. This quick action cuts off drafts, confines the blaze and reduces losses. No other type of fire door provides all of these important features: Underwriters' Label; vertical roll-up action, minimum space demands; all-metal construction; Bonderite-protected plus rust-inhibiting synthetic baked enamel; and quality built for long life. You will find a Mahon Automatic Fire Door or Shutter to suit your use . . . your property . . . your protection.

SEND FOR DESCRIPTIVE CATALOG G-60 OR SEE SWEET'S FILES

THE R.C. MAHON COMPANY
Detroit 34, Michigan

MANUFACTURING PLANTS—Detroit, Mich. and Los Angeles, Calif. BRANCH OFFICES in New York, Chicago, Los Angeles and San Francisco. SALES REPRESENTATIVES in all other principal cities.

M A H O N

OTHER MAHON BUILDING PRODUCTS INCLUDE UNDERWRITERS' RATED METALCLAD FIRE DOORS

Champion Fire Fighters

COMPRESSION TYPE FIRE **HYDRANT**

MH

Above all else, M & H Fire Hydrants are reliable and dependable fire fighting equipment. They deliver when the need arises, if there is water in the mains. Their high flow efficiency is due to an unobstructed, large waterway which has the same diameter its entire length.

Dry top, dry barrel when not in use, eliminates danger of damage by freezing. Operating parts are bronze or bronze bushed. Easy to lubricate.

Manufactured according to A. W. W. A. standard specifications or Underwriters and Factory Mutuals approved; in conventional model, traffic model or flush-type model; sizes 4¼, 4½, 5¼ and 6¼. For complete information, address

M&H VALVE
AND FITTINGS COMPANY
ANNISTON, ALABAMA

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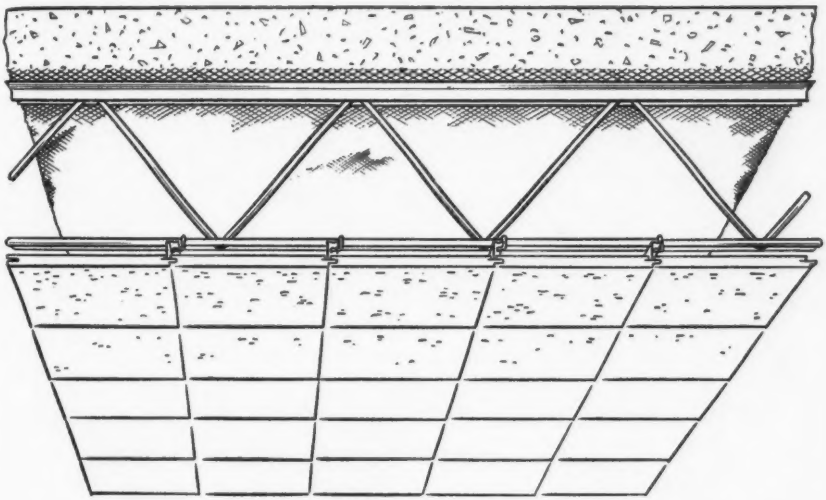

Armstrong Acoustical Fire Guard protected steel bar joists for the three-hour duration of Underwriters' Laboratories, Inc., Retardant Test #4177-3. Floor-ceiling assemblies using Acoustical Fire Guard as the only protective element beneath the structural members have received one-, two-, and four-hour time-design ratings.

New Acoustical Ceiling Tile Forms Effective Fire-Retardant Membrane

Armstrong Acoustical Fire Guard is an acoustical ceiling tile which retards the passage of flame and dangerous transmission of heat. It is the first and only time-design-rated acoustical ceiling tile.

Floor-ceiling assemblies using Acoustical Fire Guard as the only protective element beneath the structural steel have received one-, two-, and four-hour time-design ratings from Underwriters' Laboratories, Inc. By eliminating the additional fire protection that used to be required between the suspended acoustical ceiling and the floor slab above, Acoustical Fire Guard makes possible significant savings in construction time and cost.

Since it was introduced one year ago, Armstrong Acoustical Fire Guard has been chosen for millions of square feet of ceilings in all major types of buildings across the country. If you would like to learn more about this remarkable ceiling, contact your nearest Armstrong district office or write to Armstrong Cork Company, 4204 Woodbridge Street, Lancaster, Pa.

Armstrong ACOUSTICAL CEILINGS

1860-1960—Beginning our second century of progress

S&J

HYDRAULICALLY ACTUATED SAFETY VALVES

When pressure drops . . . the spring-tensioned S&J valve closes tight – quickly! Positively! In LPG tanks, pipe lines, and manifolds, the S&J Internal Safety Valve (Fig. 6129) is your most reliable safeguard. 5 sizes: 2", 3", 4", 6", 8". Get the facts: your inquiry will receive immediate attention.

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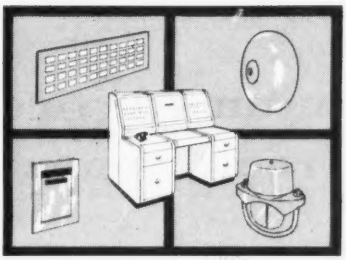


NOTIFIER'S

FIRE PROTECTION AND SECURITY SYSTEM

- - - protects another of the nation's outstanding buildings.

Notifier is entrusted with the responsibility of protecting the National Bank of Detroit's new Main office in the heart of Detroit's financial district.

NOTIFIER WAS CHOSEN BECAUSE OF:

- **Flexibility for meeting complex requirements**
- **Advanced electrical design**
- **Reliable performance over long life**
- **Plug-in components to permit easy maintenance**

National Bank of Detroit
Architects-Engineers: Albert Kahn Associated Architects and Engineers, Inc., Detroit

Do you have special plant protection problems? Let us help you solve them with Notifier's modern electronic equipment. A Notifier Sales Engineer will give you complete data on basic systems.

NOTIFIER CORPORATION
3700 North 56th St. Lincoln, Nebraska

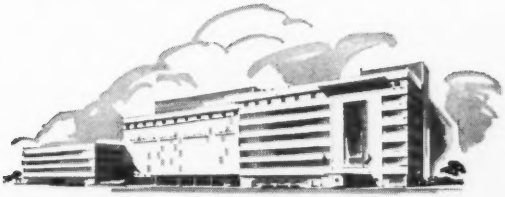
NOTIFIER FIRE ALARM

Mr. Lester C. Breitzman, Assistant Fire Marshal, Bureau of Fire Prevention, Evanston, Illinois, says:

"This automatic fire meets every requirement

Assistant Fire Marshal Breitzman at the central fire alarm panel, located just inside the main entrance. A fire in any of the three Washington National Buildings will sound an alarm here, and cause a light to flash, indicating the exact floor and building. Firemen can thus pinpoint the trouble-spot immediately.

detection and alarm system of our safety code."



WASHINGTON NATIONAL INSURANCE BUILDING
EVANSTON, ILLINOIS— *Architect-Engineer: Graham, Anderson, Probst and White, Chicago • General Contractor: A. L. Jackson Company, Chicago • Electrical Contractor: Carrier Corp., Chicago • Mechanical Contractor: Hyre Electric, Chicago*

The Washington National Insurance Building is protected by a Honeywell system that detects fire and sounds an alarm in the building and at the Fire Department.

"This fire protection system is ideal for an insurance company," says Chief Breitzman. "Detectors throughout the building will automatically detect a fire and ring alarms in the building and at our fire station. The 552 detectors installed here function as 552 watchmen, on 24-hour duty."

The Washington National Insurance Building also has manual pull stations for double protection. Either will sound the alarm and indicate the location of the fire on a panel in the lobby and at console in the Chief Engineer's office.

The system is so foolproof, it will trip the alarm even with a ground or a break in both wires of the detecting loop. A standby battery makes sure the alarm will go off even during a power interruption. The components of the system are listed by U. L. and backed by fast, efficient Honeywell service.

Honeywell's complete line of automatic fire detection and alarm systems meet the most rigid safety codes. For information, call your nearby Honeywell office. Or write Honeywell, Dept. QN-4-76, Minneapolis 8, Minnesota.

Mr. Clifford Fohr, Second Vice-President of Washington National, and Marshal Breitzman discuss a fire detector in the main lobby. Breitzman explains that the detector can sense a fire as much as 25 feet away.

75th YEAR ENGINEERING THE FUTURE

Honeywell

First in Control

SINCE 1885

Send For This FREE Catalog!

. . . 28-page illustrated booklet contains factual information on methods of fire detection, fire prevention, fire control and fire extinguishment.

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At Gillette...

It's GAMEWELL Fire Protection

"During periodic fire drills at Gillette, a Gamewell fire alarm system has proved itself much faster, much more trouble-free than the one it replaced. We appreciate the excellent protective value of the Gamewell system and your aid in engineering it to cover all buildings in our plant area."

A Gamewell System can be engineered to safeguard *your* business from fire losses . . . warn all personnel . . . signal local fire department. If required, will include fire detection units that activate entire system automatically. For details, write THE GAMEWELL COMPANY, 1335 Chestnut St., Newton Upper Falls 64, Massachusetts.

HOWARD SPAULDING
Chief Electrical Engineer
Gillette Safety Razor Company
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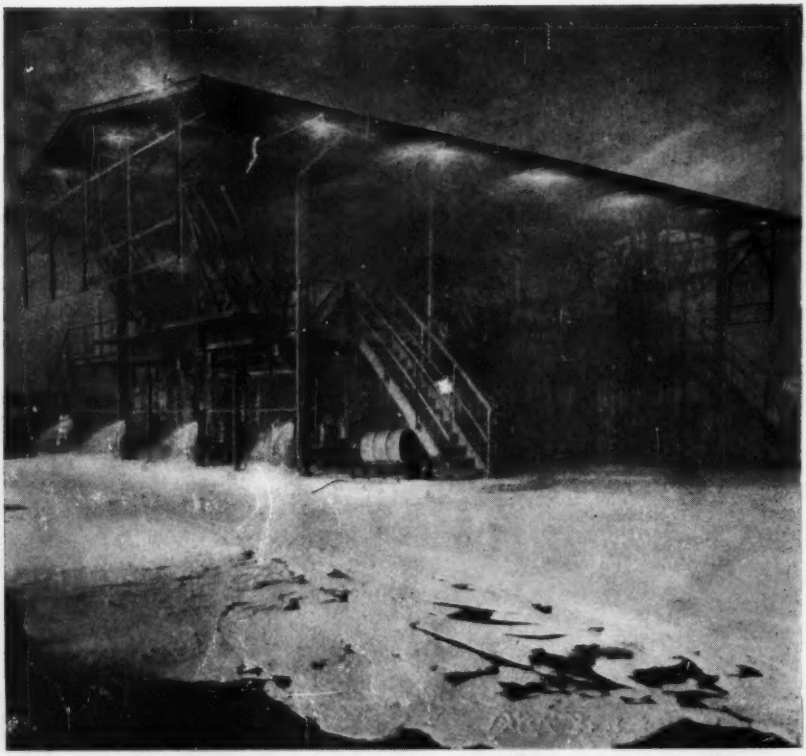
Gamewell®

FIRST...WHEN SECONDS COUNT



2 minutes after start of system under test. Note how fire-extinguishing foam blankets potential fire area.

This test shows how Grinnell's Spray-Foam System protects hazardous fire areas

In the dramatic illustration shown above, you see a Grinnell Spray-Foam System under test at a truck loading terminal in Detroit, Michigan. This fire-quenching foam system, designed for hazardous areas, is especially recommended for quelling blazes in petroleum base products, such as in gasoline, kerosene and fuel oil. Grinnell Systems are effective in controlling fires in chemicals, alcohols, benzol, solvents, paints and liquid gas.

For information about Grinnell Fire Protection Systems . . . and a Quick Selector Chart to help determine the most economical system for your fire hazard, write for Grinnell's 44-page manual "Special Hazard Fire Protection." No obligation. Write Grinnell Company, 227 West Exchange Street, Providence 1, Rhode Island.

Grinnell Fire Protection Systems include:

- Automatic Spray Sprinkler Systems: wet pipe, dry pipe, deluge and Simplex*
- Water Spray Systems with regular or Selfcon* (self-contained) water supplies; Multitrol* or Multimatic* valve; ProtectoSpray* nozzles or Mulsifyre* projectors
- ProtectoFoam* systems, producing mechanical foam
- Carbon dioxide systems
- Dry chemical systems

*Reg. U.S. Pat. Off.

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